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Contents for January, 1931

DOWNTOWN NEW YORK . . . . . FRONTISPIECE 178
The Camera Goes Impressionistic

MACHINE AGE POLITICS . BY CHARLES A. BEARD AND WILLIAM BEARD 179
The Technological Drive in Government

AN AMERICAN FARADAY . . . . . BY KARL T. COMPTON 183
The Life and Achievements of Elihu Thomson

TREATING FOOD WITH LIGHT . . . . . BY JOHN J. ROWLANDS 187
Ultraviolet Irradiation in Nutrition, Its Value and Limitations

THE TABULAR VIEW 170
Notes on Contributors and Contributions

THE TREND OF AFFAIRS 191
The Past Month in Science and Engineering

BOOKS 199
Review and Comment

THE INSTITUTE GAZETTE 200
Relating to the Massachusetts Institute of Technology

THE COVER . . . . . *From a Water Color by* EDGAR I. WILLIAMS

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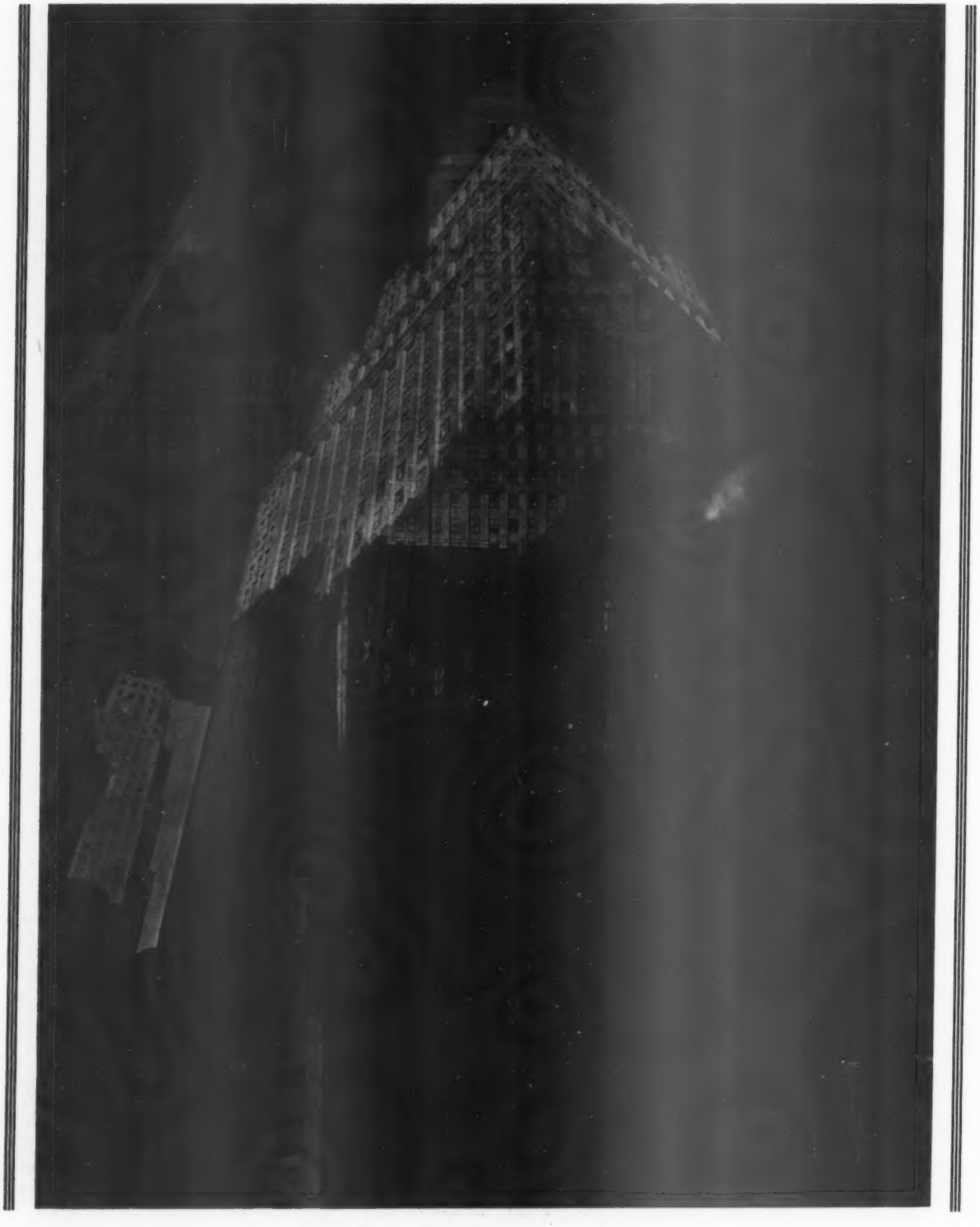


DOWNTOWN NEW YORK

THE CAMERA GOES IMPRESSIONISTIC

From a photographic composition by Ammya

THE TECHNOLOGY REVIEW

VOLUME 33 JANUARY, 1931 NUMBER 4

MACHINE AGE POLITICS

The Technological Drive in Government

BY CHARLES A. BEARD AND WILLIAM BEARD

WHILE the Ship of State sails majestically into the unknown waters of the future, many onlookers appraise her. Those with the loudest voices, it seems, are loath to divorce themselves from traditional views, however proudly they may boast of scientific disinterestedness in other matters. Consequently they see her through colored glasses. Noticing the continued prominence of such ancient devices as legislatures, councils, executives, cabinets, courts, juries, and bureaus, they conclude that the stanch old craft is just about the same as she was in sloop and clipper days. According to these commentators, she has been insulated from most of the changes so evident in other phases of human creation.

In truth, this is just one of the many myths current in our time. The very advances in science and machinery that have so markedly revamped the society in which we live have inevitably induced a parallel technological drive in government. Under the influence of this force the Ship of State is being renovated from stem to stern. She has new machinery aboard. Her sails are being replaced by powerful industrial engines — call them Capitalism, Communism, or what you will — and her inherited crew of spoilsmen is giving way all along the line to technicians. A little inspection of the facts in this amazing transformation soon shows why the Ship of State is no longer the fine old antique which some people imagine.

To drop the figure, the technological drive in government has enormously increased the duties discharged by the State in every direction, raising the number of employees from the thousands to the millions, drafting into service all the arts and sciences known to man and making use of all the materials listed under physics and chemistry. In many cases this extension is the result of realistic pressures exerted by groups formed around the new devices of technology themselves — the regulation of railways, telephones, telegraphs, cables, steamships, and electric power serving as an illustration. Again, other functions of State spring up in connection with discoveries and inventions because there is a growing consciousness of their possibilities for good — the promotion of safety and public health, for instance. Are not accumulating and expanding ideas as substantial as the dynamics with which engineers must reckon? Finally, numerous State activities are the product of technical circumstances so exigent as to be well nigh unavoidable. In the last category falls the supervision of wireless communication.

Galloway

WEATHER FORECASTING, AN EXAMPLE OF TECHNOLOGY IN GOVERNMENT

To enlarge upon this single phase, if a year must be chosen for its appearance, it may well be 1912 when the *Titanic* disaster fixed the attention of the governments of the world on the radio. A few weeks afterward, the civilized nations of the earth sought to provide, through international arrangement, for some kind of control over the new medium for telegraphy-without-wires, and the United States, in spite of its "isolation," had to join them in self interest. This gave the signal for increasing action. But has it

been really necessary for our Government to interfere in any way with private enterprise in this field — "necessary" somewhat in the sense in which that word is employed by engineers?

History offers illuminating evidence. In July, 1926, the Attorney-General of the United States ruled that our Secretary of Commerce, under existing acts, was without power to control broadcasting. Before long, as Commissioner Caldwell of the Federal Radio Commission pointed out, many stations "jumped without restraint to new wave lengths which suited them better, regardless of the interference they might be causing to other stations. . . . Stations were soon wildly blanketing each other while distracted listeners were assailed with scrambled programs. . . . Meanwhile 250 new stations had injected themselves into the already overcrowded situation and undertook to find perches on which to light . . . and heterodyne interference between broadcasters . . . became so bad at many points on the dial that the listener might suppose instead of a receiving set he had a peanut roaster with assorted whistles. Indeed, every human ingenuity and selfish impulse seemed to have been exerted to complicate the tangle in the ether." In 1927 federal regulation was resumed with highly beneficial results. Experience in two periods of anarchy — the first prior to 1912 during the infancy of the art, and the second after 14 years of orderly development — give testimony to the inescapable fact that the radio, a modern brain child, requires careful and constant government nursing. And so do a number of other technical devices of today.

Not only has technology added wholly new tasks, such as those just cited above, to the work of governments; it has also rendered far more burdensome the discharge of many very ancient functions. It has revolutionized the military and naval protection of the state, the taxation of property, and the supervision of weights and measures — all duties of ruling bodies from the dawn of civilization to the latest moment.

How technical progress has made its mark on old practices may best be indicated by a concrete case. The federal Constitution provides that Congress shall have power to fix the standards of weights and measures. When that famous document was written, its framers had in mind only the relatively simple matter of maintaining rough standards of length, mass, and volume. But the growth of science wrought substantial changes in the years that followed. For example, it has added many new units in electricity — the ohm, the volt, and the ampere. It has produced the candlepower as a measure of illumination, and the curie as a gauge of radio-activity. As if an expansion in the gross number of items were not enough, science has demanded measurements made with a precision never dreamed of in the Eighteenth Century. Today instruments can be calibrated to the nearest millionth of an inch by comparison with the apparatus of the Bureau of Standards. In another line of physics, that federal organization has developed a delicate device capable of responding to the heat radiated by a candle 100 miles away. The wide range of units employed in modern industry, therefore, and the astounding accuracy with which they must be determined, have entirely overhauled the original federal weights and measures administration, adding immense burdens to a once easy function.

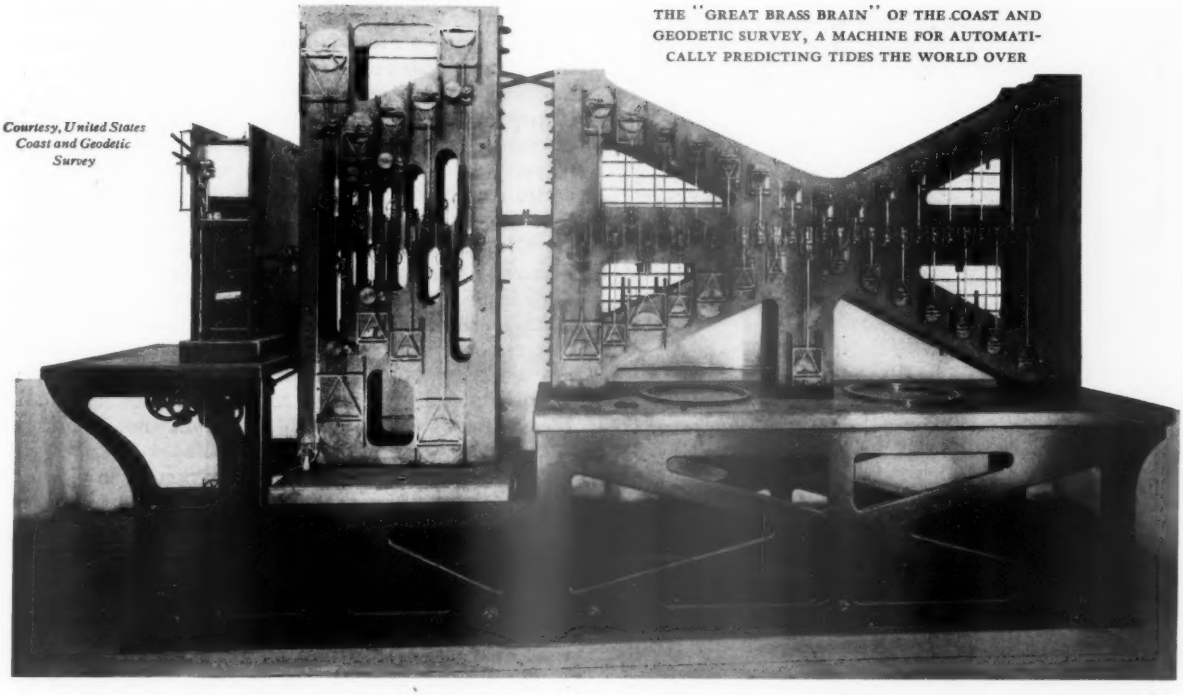
UNDER the drive of technology some 40 federal bureaus and commissions primarily technical in character, outside of the War and Navy Departments, have been brought into being. In theory this mass of executive bodies is subject to the laws passed by Congress. But is Congress technically equipped to legislate on steamboat inspection, aviation, radio, geodetic surveying, and the like? Can it intelligently direct this huge organism, this administrative leviathan? In an age of specialization, is Congress really representative of the various trades, professions, and competence groups? An examination of the biographies of the 96 members of the more important branch of Congress, the Senate of the United States, throws light on the matter. As of January, 1930, over half of the Senators were listed as lawyers. Among the rest were one civil engineer, one mining expert, one physician, one well driller, and a scattering number of business, agricultural, and educational spokesmen, with four or five manufacturers. This being the case, the upper house is evidently not equipped with the specialized knowledge necessary to deal effectively with many matters of a technical nature that come before it. Nor is the House.

Galloway

DIFFUSION BATTERY IN SUGAR LABORATORY OF BUREAU OF STANDARDS, A SCIENTIFIC ENTERPRISE OF THE GOVERNMENT

THE "GREAT BRASS BRAIN" OF THE COAST AND GEODETIC SURVEY, A MACHINE FOR AUTOMATICALLY PREDICTING TIDES THE WORLD OVER

Courtesy, United States Coast and Geodetic Survey



How, then, are the minute realities of government to be handled in the machine age? If legislatures are lay bodies while executive agencies, at least on the enforcement front, are technically competent, is it not inevitable that a large part of the burden of law-making must be shifted from the former to the latter? In practice, this is just what is happening in ever-widening areas of government. Congress is constantly enacting statutes in vague and general language, turning over to administrative officers the right and duty of filling in the details and giving technological substance to them.

The process is well illustrated by federal steamboat inspection. In a comprehensive act, Congress provided that a Board of Supervising Inspectors appointed by the President and Senate shall have power to adopt rules and regulations as to the design and equipment of all steam vessels subject to federal control. When approved by the Secretary of Commerce, the requirements of the Board have the force and effect of law. While Congress saw fit to set up a few guiding principles, it merely scratched the surface. For example, the statutes prescribe that "all such vessels shall comply with the following requirements, namely: that the boilers are well made, of good and suitable material; that the openings for the passage of water and steam, respectively, and all pipes and tubes exposed to heat, are of proper dimensions. . . ." But the Board of Supervising Inspectors must decide when a boiler is "well" made, when its materials are "good and suitable" and when openings and pipes are of "proper" dimensions. Such matters it has treated in four volumes, the one relating to ocean and coastwise vessels alone containing 297 pages of compulsory standards.

In effect, then, science and machinery have made such rigid demands for technical competence on the legislature that they have forced a definite and irreparable break in the boundary between the executive and law-making functions. Indeed no less an authority then Elihu Root has recognized this fact. In an address before the American Bar Association in 1916 he openly declared that "the old doctrine prohibiting the delegation of legislative power has virtually retired from the field and given up the fight . . . because [executive] agencies furnish protection . . . which under our new social and industrial conditions cannot be practically accomplished by the old and simple procedure of legislatures and courts as in the last generation."

UNFORTUNATELY there are times when Congress, in its anxiety to avoid details, passes general laws whose terms, though brief, are still technically well nigh impossible to follow. Thus the federal fund from which loans are made to shipping companies for construction work may be employed only in the aid of "vessels . . . fitted and equipped with the most modern, the most efficient, and the most economical engines, machinery, and commercial appliances." To the United States Shipping Board is lightly entrusted the interesting task of deciding what vessels are simultaneously the "most modern, most efficient, and the most economical." Since the "most modern" liners today must sacrifice economy to speed and since the maximum attainable efficiency often involves expensive equipment which may well prove uneconomical in a commercial sense, the law in this case is merely something with which to conjure. How the three qualities can be combined in one is certainly a poser. The laymen who enacted the bill did not have to accomplish the feat. They "passed the buck" to naval architects.

We have just pointed out some effects of technology on the executive and legislative branches of the government. It is equally important to illustrate the influences exerted

Underwood and Underwood

SHOSHONE DAM, ONE OF THE GREAT STRUCTURES BUILT BY THE U. S. RECLAMATION SERVICE

by science and machinery on the judicial branch. First of all they have greatly multiplied and diversified the business before the courts and in some instances forced the establishment of special tribunals to hear new types of cases. The coming of the motor vehicle, for example, has placed 25,000,000 mobile units on our highways and brought about complicated traffic regulations. The results are known to everyone. Violations of parking rules, passing signal lights, speeding, and similar acts make for many arrests. If such matters are handled in the regular courts, congestion, lack of uniformity, and the wholesale dismissal of charges without hearings, to clear the dockets, are apt to result. To meet the situation, many large centers have created special "traffic courts" exclusively for the hearing of motor vehicle cases. Indeed, the *American City* of June, 1929, estimates that such specialization might often be necessary in towns with a population as little as 15,000.

But the movement towards the establishment of special courts is slow — perhaps because the law is the most traditional of our professions. Despite repeated attempts to secure a separate patent tribunal, Congress has refused to do more than separate patents from the general run and combine them with the customs under a single jurisdiction. What, then, are we to do to insure technical competence in trials involving violations of steamboat inspection rules, air traffic regulations, and the like, when judges remain men of all work? If "courts" cannot be formed to deal with such questions, what alternative is there? In practice a solution has been found in the delegation of many judicial ("quasi," as lawyers will have it) functions to executive bodies trained in scientific work.

A specific case is worth a mine of generalities. Instead of creating a special court to deal with the design and manning of modern power-driven vessels, Congress has vested a certain judicial responsibility in administrative agencies — local boards of steamboat inspectors for the several districts into which the United States is divided. Under the authority granted by the national legislature, these boards, among other things, investigate all acts of incompetency and misconduct on the part of licensed ship officers. They may summon witnesses and compel their attendance by a process similar to that employed in the United States district courts and they may administer all the necessary oaths to the same. They may hold hearings and examine the witnesses, and, if the revelations warrant, revoke the licenses of the guilty parties. In view of the fact that such revocation throws the accused person out of a skilled job, this act is most certainly a serious type of punishment, akin to a fine or other penalty imposed by a regular tribunal. Nor is the mimicry of the judiciary yet complete; a system of appeals is provided. In case the defendant is dissatisfied with the decision of the local board of steamboat inspectors, he may carry the matter to the Supervising Inspector General, whose determination shall be final when approved by his chief — the Secretary of Commerce. Furthermore, in these appeals the accused shall have the right to be represented by counsel and to testify in his own behalf.

TURNING from a discussion of the technological drive in the executive, legislative, and judicial branches to certain larger aspects of government, the influence of science and machinery is again found at work. For one thing, it has revolutionized our concepts of the size of an efficient State. Aristotle, in his *Politics*, declared that "a state when composed of . . . too many [people,] though self-sufficing in all mere necessaries, . . . is . . . almost incapable of constitutional government. For who can be the general of such a vast multitude, or who the herald, unless he have the voice of a Stentor?" Although Stentor, as a herald in the Trojan war, had a famous throat, he could only reach a few thousand auditors at a time. By Greek standards the United States, with over a hundred million people, could only be a clumsy monstrosity.

Until the radio age Aristotle's judgment seemed to have warrant. As our population grew at a phenomenal rate, the distance between the national executive and the man-in-the-street widened to correspond. True, heroic efforts were made by presidential nominees to reach the people but they produced feeble results at best. The most famous attempt, perhaps, was that of William Jennings Bryan who conducted a 14-week pre-election campaign in 1896, during which he traveled some 18,000 miles, delivered 600 speeches, and managed to get 5,000,000 souls within the sound of his voice. Human toil could scarcely do more; still the traveling statesman failed to reach whole sections of the country. And it is significant that with the growth of population political statistics recorded a declining public interest. (*Continued on page 204*)

AN AMERICAN FARADAY

More than Any Man Now Living, or Perhaps That Ever Lived, Elihu Thomson Combines the Constructive Powers of the Inventor, the Thoroughness of the Scientist, the Balance of the Philosopher

By Karl T. Compton

From a portrait by Frank W. Benson

PROFESSOR ELIHU THOMSON

AT THE age of 11, being too young to enter high school, Elihu Thomson obtained several boys' books on scientific and mechanical subjects, and inspired by these, proceeded to construct for his own amusement a variety of the electrical devices which were the absorbing scientific interest of that day, such as batteries, Leyden Jars, electromagnets, and telegraphic instruments. He constructed a frictional static machine out of an old wine bottle and when his father did not seem sufficiently impressed by the tiny sparks it produced, he went to work and constructed a large static battery which he demonstrated to his father so effectively as to lay him almost out.

This interest and genius, already evident at the age of 11, has been equally evident throughout the long and wonderfully active career of Professor Thomson. Because of this he has been aptly called "the dean of electrical engineers". He is the holder of more than 700 U. S. patents, which is the third largest number held by any living man. He is honored and respected by every scientific, engineering, and educational institution in the world (from 1921–1924 he was Acting President of M. I. T. and at present he is on its Corporation and a non-resident member of its Faculty), and in Lynn, Mass., he is more than any other man responsible for the great electrical industry which supports thousands of people there. Commenting recently on Professor Thomson's contributions to the General Electric Company, Owen D. Young recently summed up the assets of the Company as $500,000,000, and with shares valued at $2,000,000,000. The difference in value between $2,000,000,000 and $500,000,000, said Mr. Young, is in a substantial part due to the ideas, inventions, and spirit which this Company owes to Professor Thomson. It is seldom if ever, that a man lives to see such a remarkable and tangible result of his life's work.

THOMSON REPULSION EXPERIMENT SHOWING ARC INCANDESCENT LAMP ATTACHED TO THE TERMINALS OF A COIL OF WIRE AND THE COIL AND LAMP FLOATED IN WATER ABOVE AN A.C. MAGNETIC FIELD POLE WHICH LIGHTS THE LAMP AND REPELS THE COIL TO DEFINITE CURRENT VALUE IN LAMP. FORERUNNER OF A.C. CONSTANT CURRENT TRANSFORMER

Although his interests have been effectively employed in many lines, it is in the field of electricity that his genius has found its greatest scope and has led to the most important achievements and widespread service. It would be utterly impossible even to mention most of these discoveries, but I shall pick out just a few of those which have been outstanding. Perhaps the first great contribution was the invention in about 1879 of the three coil arc dynamo with its automatic regulator and other features, which formed the basis of the first successful electric lighting system, which was put out by the Thomson-Houston Company in 1880, and which quickly found its place not only in this country but also in the leading countries of Europe. The machine was entirely automatic in its operation and so adjusted that it could maintain constant regulation in a system of many electric arcs, no difference how many of these arcs

EARLY MODEL OF THOMSON CONSTANT CURRENT TRANSFORMER

might be turned off or on. The need for such a regulator and its general nature were suggested to him by his earliest serious electrical studies, which were on the relation between the current and voltage in an electric arc, and which led him to the discovery that as the current increases the voltage falls — a relation which accounted for instability and pointed out characteristics which an arc dynamo should have.

It is interesting to note that this three coil dynamo was a direct current machine provided with a commutator, since in those days direct currents were more readily handled than were alternating currents and had certain advantages for arc lighting purposes. However, exactly the same machine, simply with different connections, constitutes the three phase generator which is so important in present day electric power and was so represented in the original patent application. This is one of many cases in which Professor Thomson's ideas were years in advance of the world's readiness for their acceptance and utilization.

About two years later (1881) there was another great invention, that of a magnetically operated lightning arrester. Although this was designed for the particular purpose of protecting his arc light systems from lightning, it was the invention of a fundamental method of breaking electric circuits, which has found very numerous applications, one of the most important of which was by Professor Thomson himself in the control of electric cars and trains.

The fundamental idea of this was again based upon an accurate knowledge and study of scientific phenomena involved in the discharge of electricity through gases. A transmission line, of course, has to be insulated from the earth by insulators adequate to prevent spark-over at the voltages used. If, however, the line is struck by lightning or an abnormally large electric surge passes through it, a spark may pass around the insulation, and it is a peculiarity of sparks through air that when once the insulation of the air is broken down by a spark there is literally no limit to the amount of current which can flow. Thus these sparks frequently cause serious short circuits.

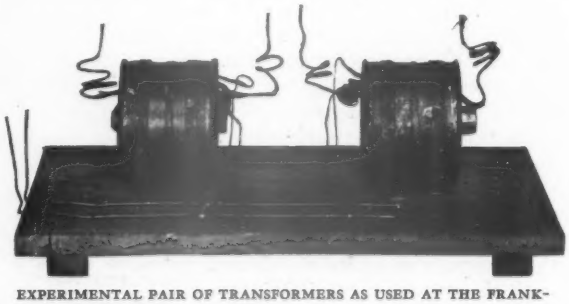
Professor Thomson's discovery consisted in placing the insulator between the poles of a magnet, with the result that the spark or arc which might be produced was acted on by electrical forces in such a way as to elongate it in the form of a bow which became more and more extended until it finally became so long that it went out. This principle is of just as great importance today as ever and is the foundation of many recently improved schemes for the switching of very large currents.

PROFESSOR THOMSON AND THE FIRST ELECTRIC WELDING TRANSFORMER WITH SINGLE-TURN SECONDARY, BUILT IN 1886

Again in these very early days and long before the importance of it was realized, Thomson invented the now universally used method of transmitting electric power, stepping it down from a high tension with the aid of a local transformer for consumption. This was set up as a working model at the Franklin Institute in Philadelphia in 1879, a patent was applied for in 1885, and after an unusually strenuous history in the patent office, the fundamental patent for multiple arc distribution systems with transformers was granted in 1902. During this same time and as an additional safety device for high voltage operation, Thomson patented the procedure of earthing the secondary coil of the transformer, a practice which has now become universal. In passing I should note here as an illustration of a notable characteristic of Professor Thomson, that this patent on his advice was dedicated by the General Electric Company to the public from a feeling that no patent or invention which has to do with public safety should in any way be restricted or made unavailable to the people.

In the further development of alternating current machinery he invented the constant current transformer and the inductive regulator in which a movable secondary or primary coil could be adjusted to give constant current output. Again in the direction of increasing the power capacity of transformers, in 1887–89 he first proposed the use of oil for cooling and for insulation purposes in transformers, and furthermore called attention to the great and deleterious effect of moisture in the oil, an effect whose full significance students of insulators are only now beginning adequately to realize.

I pass now to two of the most important and characteristic of Professor Thomson's discoveries. The first of these is that process of electrical welding whereby the welded surfaces were fused and united by the heat developed on account of the resistance in the contact between them. This method of welding has come into enormous use in industry and the indications are that it will be even more used in the near future. As examples in widely different fields may be mentioned the welding of seamless metal tubing, the attachment of filaments and other electrodes in incandescent lamps and vacuum tubes,

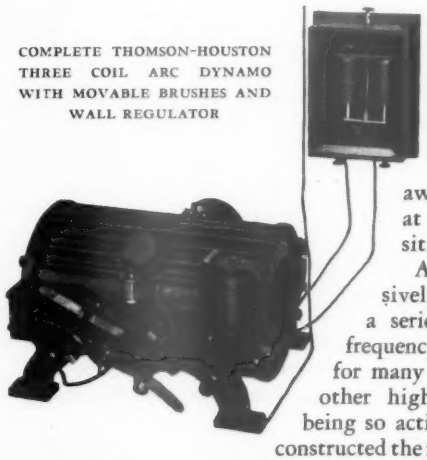


EXPERIMENTAL PAIR OF TRANSFORMERS AS USED AT THE FRANKLIN INSTITUTE, PHILADELPHIA, JANUARY AND FEBRUARY, 1879, IN PIONEER A.C. TRIALS

and the fastening together of most of the parts of the new Ford automobile. In the former of these applications it may be interesting to know that a single manufacturer had manufactured, a few years ago, about 24,000 miles of bedstead tubing by this process in a single year.

Professor Thomson was not the first to utilize an arc in welding. There was some previous art, such as Slavianoff and DeMeritens, but the Demeritens patent, which was fundamental, was bought on advice of Professor Thomson by the Thomson Electric Welding Company in the early days, and had arc welding developed within the life of the patent, that company would have controlled the arc as well as the electric resistance welding art.

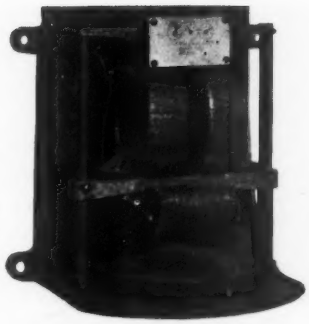
Again, one of Professor Thomson's most fundamental discoveries was the principle of dynamical repulsion between a primary and secondary coil. This can be demonstrated by a variety of interesting lecture experiments, most of which were suggested and shown first by Professor Thomson himself (see page 183). One of these is an experiment which invariably arouses cheers in our freshman classes. A vertical wire core is surrounded by a spool of wire through which a large current can be passed upon throwing a switch. A metal ring which slips easily over this core is dropped around it from above. Immediately upon closing the circuit this ring is shot up into the air by the repulsive action by the electric current produced in the ring and the primary current in the coil. This scientific observation was developed by Professor Thomson into an alternating current repulsion motor which is nothing more nor less than our ordinary induction motor, which is in almost universal use for small single phase motors.



COMPLETE THOMSON-HOUSTON THREE COIL ARC DYNAMO WITH MOVABLE BRUSHES AND WALL REGULATOR

In connection with this discovery you will be interested in the following quotation from the *Electrical World* of May 28, 1887 commenting upon this work:

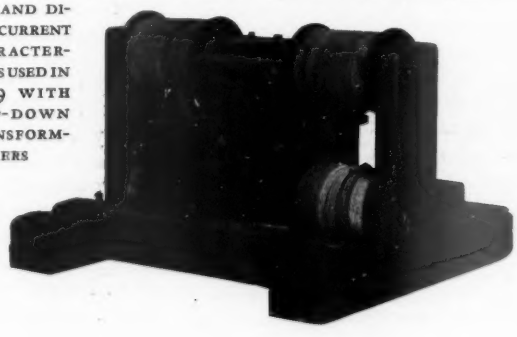
"It is, as yet, too early to assign to its proper place and limit the part which the alternating current will take in the electric arts. It has started on its career with most rapid strides, and it now only remains to devise means for its accurate measurement, regulation, and distribution. Certain it is that Professor Thomson's brilliant paper cannot fail to act as a powerful stimulus to those whose attention is now absorbed in the direction indicated, and the fruits of which will soon be noted. We hope that at a later meeting of the Institute Professor Thomson will give to the world his practical results, which he has only hinted at in the present paper." These practical results are now seen, for example, in probably a million induction motors in daily use.



THOMSON RECORDING WATTMETER OF THE TYPE WHICH TOOK THE PARIS PRIZE OF 1890

During the years 1885–1895 Professor Thomson was busily engaged with the development of electric meters of which more than 4,000,000 are now in operation. It is these meters which tell you and the public service corporation the amount of your monthly electric bill, and for this invention Professor Thomson was awarded the Paris Meter Prize of 1890 at a competition held after the exposition of 1889.

As early as 1890 and continued intensively for half a dozen years thereafter were a series of brilliant experiments on high frequency alternating currents, paving the way for many of the developments in wireless and other high frequency applications which are being so actively applied at the present time. He constructed the first high frequency dynamo, operating at frequencies of 30–40 times as great as any previously designed, and in connection with experiments with this type of electric power he designed also the first special high frequency transformers. While working in this field he discovered a method of producing still higher frequency alternating current from a direct current arc, by shunting the arc with inductance and capacity, thus discovering the method which played such an important rôle in wireless transmission up until its virtual replacement by electronic tube devices only within the past few years. This interesting method of producing alternating currents was actually applied to wireless telegraphy by Poulsen, and is therefore generally known as the Poulsen arc. Also in connection with these high frequency investigations, he made the important discovery that the insulating power of oils at these high frequencies is very much greater than at the ordinary low commercial frequencies, if this insulating power is measured in terms of the path at which a spark will pass. Just one other item can be mentioned in connection with his high frequency work, namely, the fact that he discovered and was the first to use the method of tuning electric circuits, which is, of course, absolutely fundamental to modern electrical communication systems. This was done very



EARLY BI-PHASE MACHINE MADE IN 1878 HAVING BOTH ALTERNATING AND DIRECTCURRENT CHARACTERISTICS USED IN 1879 WITH STEP-DOWN TRANSFORMERS

early in his career while he was still a professor at the Boys' Central High School in Philadelphia, and was done in connection with experiments on wireless signaling which antedate the famous experiments of Hertz by about a dozen years, and as far as I have been able to ascertain constitute the first experiments on the propagation of electric waves and wireless signaling, with the sole exception of some experiments conducted still a dozen years previous to his by Joseph Henry in Princeton. These earlier experiments of Henry's were apparently never published but were used for the very practical purpose of allowing his wife to call him when his meals were ready.

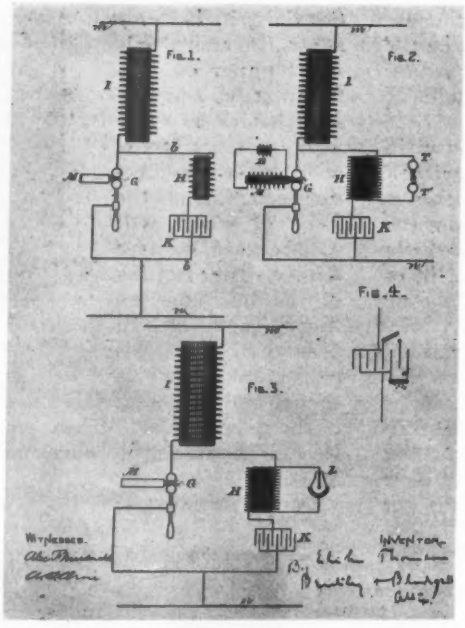


DIAGRAM OF THOMSON METHOD FOR OBTAINING A.C. CURRENT OF A WIDE RANGE OF FREQUENCY FROM D.C. SUPPLY

Immediately upon the announcement of the discovery of Röntgen rays Professor Thomson began a series of interesting experiments and valuable developments in connection with the x-ray art. The foundation for this work had been laid by previous experiments on electric discharge through gases at low pressures, and led to the first application of stereoscopic methods in Röntgenology only one year after the publication of the Röntgen rays themselves had been announced, and led also to various practical improvements in the design of x-ray tubes, as for example, the double focus x-ray tube and a cooled target tube within less than a year after the discovery of Röntgen rays. In connection with these experiments Professor Thomson also took a lively interest in the physiological effects of x-rays including x-ray burns, and in the laws governing diffusion in x-ray matter, subjects which have been developed on the one hand to exceedingly important applications in medical therapy, and on the other hand to give some of the most intimate knowledge which we possess of the internal constitution of matter, such as the arrangement of atoms in crystals and molecules, and the arrangement of electrons in atoms.

PROFESSOR THOMSON has not confined his activity exclusively to electrical science. Jointly with his first colleague, Houston, he invented and patented the continuous centrifugal cream separator in the years 1877–1881. This was a device applicable to the separation of substances of different densities and has come into universal use in the cream industry, as well as in the laboratory and elsewhere, for centrifuging mixtures which it is desired to separate. A typical claim in this patent is this: "a process of creaming milk mechanically, skimming off the cream mechanically, and removing the skimmed milk mechanically, by centrifugal force." At that time Professor Thomson could not have dreamed that this same process of separating materials by centrifugal force would later be used by a brilliant young physical chemist of the Institute of Technology for separating the molecular ions of electrolytes and obtaining their relative weights.

In the field of steam engineering Professor Thomson in 1899 produced a steam engine of remarkable efficiency which is now generally known as the "uniflow" engine. He described the principle on which this engine was based in the following words:

"The conditions are such that there is no re-traversing of passages, no re-traversing of even the cylinder portion. The steam enters, goes forward and out, keeps running steadily forward, so that we do not have any of those inter-actions that use up energy. We have a temperature gradient from one end to the other of steam cylinder."

Again in 1894 he devised a muffler for automobiles antedating the Maxim silencer and in many respects similar in principle. This muffler was based upon a sound scientific principle of dividing up an impulse or sound wave so that it should traverse a number of paths of unequal length, so that when these divided impulses all came together again, they should be out of phase and partially neutralize each other so as to take away or spread out the shock of the initial impulse. I can only mention further in the field of automotive engineering that Professor Thomson devised numerous types of gas and oil engines or improvements in their construction.

PROFESSOR THOMSON INSPECTING FUSED QUARTZ ASTRONOMICAL MIRROR — ONE OF HIS EXPERIMENTS LEADING TOWARD THE CONSTRUCTION OF A 200-INCH MIRROR

IN QUITE a different line of activity Professor Thomson's interest has continued unabated from the time quite early in his career in 1878, when he published

(*Cont. on page 210*)

THE RESULT OF AN EXPERIMENT CONDUCTED FOR THE REVIEW BY R. S. HARRIS OF THE INSTITUTE'S DEPARTMENT OF BIOLOGY AND PUBLIC HEALTH. AT THE BEGINNING OF THE TEST THESE RATS EACH WEIGHED 51 GRAMS, WERE 30 DAYS OLD, AND WERE TAKEN FROM THE SAME LITTER. THE RAT ON THE LEFT WAS FED A DIET RICH IN VITAMIN D FOR 24 DAYS. HE SHOWS NORMAL GROWTH. THE RAT IN THE CENTER WAS FED A DIET CONTAINING NO VITAMIN D FOR 24 DAYS. HE HAS SEVERE RICKETS AND GAINED BUT 9 GRAMS DURING THE TEST. NOTE THE SHORTENED NOSE AND BODY. THE RAT ON THE RIGHT WAS FED THE STEENBOCK DIET (CONTAINING NO VITAMIN D) BUT IN ADDITION HE RECEIVED IN ISOLATED DOSES 10 UNITS OF VITAMIN D DAILY, OR 10 TIMES WHAT HE NEEDED. WHILE HE DID NOT GET RICKETS AS DID THE CENTER RAT, HE GAINED BUT 8 GRAMS AND THE WETTED APPEARANCE OF HIS FUR, A SIGN OF ABNORMAL ORGANIC FUNCTIONING, INDICATES THAT TOO MUCH VITAMIN D MAY BE HARMFUL

TREATING FOOD WITH LIGHT

Ultraviolet Irradiation in Nutrition, Its Value and Limitations

By John J. Rowlands

UNTIL 1801 man did not know that ultraviolet light existed. Since its discovery at that time by Johann Wilhelm Ritter (1776–1810), an amazing variety of chemical and physiological effects deriving from it have been demonstrated. In fact life has been shown to be dependent upon ultraviolet and illness to be amenable to its therapeutic effects.

These things being known, it was natural that scientists should set about to devise means for producing it artificially and methods for making it available in ways more manifold than exposure to sunlight. During the last decade a multiplicity of sunlights have been contrived, some good, others worthless, to emit ultraviolet, and commercial interests with more high pressure than science, have brought the public into the picture by marketing these artificial sources for indiscriminate use.

In the meantime, working deliberately and carefully from another angle, the physicists and biochemists began discovering strange but richly profitable facts about the relation between ultraviolet light and vitamin D, that "accessory food factor" which prevents and cures rickets, the scourge of babies. Sir Frederick Gowland Hopkins, as far back as 1912, demonstrated the presence and need of these accessory food factors, later to be called vitamins. The subsequent relating of ultraviolet light to one of the most important of these was a capital achievement for the biochemist. It has brought about the irradiation of foods with ultraviolet light, a development more important than quick freezing which is just coming of age, and the many other improvements devised by scientists for treating, handling, and improving the world's food.

Before describing the important advances lately made in food irradiation, a precautionary word is appropriate. If ultraviolet lamps can be exploited by some manufacturers and misused by the public, then it is probable that food treated by ultraviolet light is susceptible to even graver abuses. Up until the present time, the evolutionary process from laboratory to commercial production has been singularly conservative and practically beyond criticism, but already there are indications of an ill wind. The public is becoming "vitamin-minded" and because American "mindedness" on any subject is prone to expand into that wild-fire type of mass enthusiasm from which intemperate fads spring, authorities feel that until more is known of the nature and specific effects of this powerful agent, the development of a national appetite for substances rich in vitamin D would be unwise (see above illustrations). Ultraviolet light is of incalculable value when properly used and quacks should not be permitted to exploit it as the modern patent medicine.

IN ORDER to understand clearly the significance of the therapeutic application of ultraviolet light, it is necessary to review briefly the advance of knowledge in this field in the past few years. What has been accomplished has sprung chiefly from developments that had their beginnings in 1919 and 1920. The first was the discovery that bone development could be controlled by diet, a fact demonstrated for the reader by an illustration upon which the accompanying illustrations are based. The second was that light also can control bone development.

The results of a painstaking study of the various steps that led to the application of light to food substances, with much valuable information on the present methods in this new field of nutrition have recently been published by Katharine Blunt, '03, President of Connecti-

cut College, and Ruth Cowan, Instructor in the Department of Home Economics of the University of Chicago.

It was Dr. E. Mellanby, an Englishman, who in 1919 reported the results of important nutrition experiments on puppies. Fed on a limited diet, these puppies developed rickets with the characteristic soft bones and bowed legs found in rachitic children. By feeding them cod liver oil he succeeded in curing some of the animals, and established the fact that rickets is a disease caused by a deficiency in diet. Mellanby, however, was unable to determine the nature of the deficiency. The fats, cod liver oil, and butter, which he found most potent in treating rickets, were the same which earlier had been shown to contain the growth-promoting vitamin A, and he concluded that in this vitamin lay the secret of the cure.

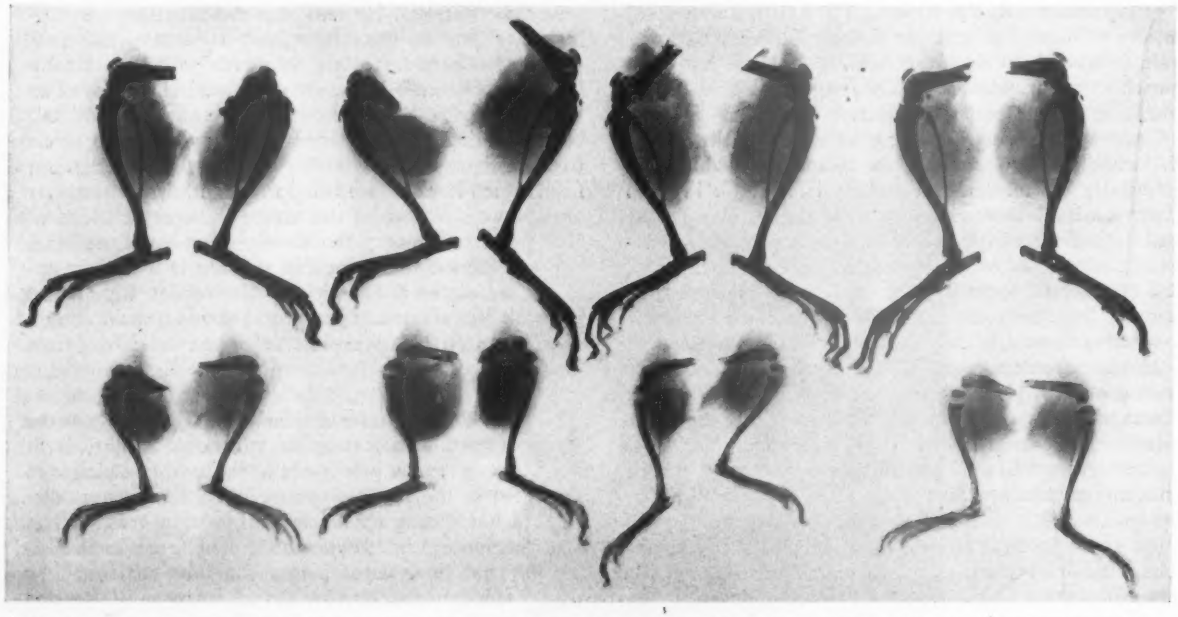
Meantime Dr. Alfred F. Hess of New York, studying a group of babies, discovered that some of his small charges living on a diet rich in milk and cream in which the vitamin A is found, were subject to rickets more readily than a group whose diet was low in vitamin A. Here was evidence indicating that vitamin A alone did not cure rickets.

It was two years after Mellanby had reported his work on puppies that E. V. McCullum and a group of workers at Johns Hopkins University established the fact that the "mysterious something" in cod liver oil that cures rickets was not vitamin A. They found that cod liver oil in which the vitamin A had been destroyed still had the power to cure rickets in their laboratory rats. Their work brought recognition of the existence of the antirachitic factor which has come to be known as vitamin D, and immediately focussed scientific interest upon that ancient remedy of the fishermen of England, Holland, and France, the repellent oil of the liver of the lowly cod fish.

The second discovery that has had much to do with the development of knowledge in the treatment of rickets was the result of the work of a German scientist, K. Huldschinsky, in Berlin in 1919 and 1920, just after the end of the World War. In the Oscar-Helene Home for Crippled Children he found tragic conditions, for a great many of the children from three to five years old were suffering from rickets, some with marked deformities of the legs, while others showed spinal curvatures. Then began the experiments in which he was to discover that mysterious radiations from the mercury quartz lamp and from natural sunlight had the power to promote rapid cure of rickets. He found, however, that these radiations could not cure the worst deformities, and he at once turned to preventative treatment by irradiation. Working in New York, Dr. Hess in 1921 also found that natural sunlight by itself would cure rickets in infants.

These discoveries — the fact that rickets could be controlled by diet, and that light also had the power to cure the disease — could not be reconciled at that time, for there seemed to be no relation whatsoever between cod liver oil and radiant energy from the sun and certain artificial sources of light.

THE answer to this scientific riddle came in 1924. Dr. Hess of New York, and Dr. Harry Steenbock of the University of Wisconsin, working independently, dis-



TOP ROW: X-RAY PHOTOGRAPH OF THE REAR LEGS OF FOUR RATS FED A DIET IDENTICAL WITH THE RAT SHOWN ON THE LEFT ON PAGE 187. NOTE THE LARGER SIZE IN BONES AND THE DARKNESS OF THE PRINT WHICH IS DUE TO THE LARGE AMOUNT OF CALCIUM IN THE BONE DEPOSITED BECAUSE OF SUFFICIENT VITAMIN D IN THE DIET. NOTE ESPECIALLY THE SMALL SPACE BETWEEN THE SHANK BONE AND THE CAP BONE WHICH FORMS THE KNEE JOINT. BOTTOM ROW: THESE ARE LEGS FROM RATS THAT RECEIVED A DIET FREE OF VITAMIN D WHICH THE RAT SHOWN IN THE CENTER ON PAGE 187 RECEIVED. NOTE HOW SMALL THE BONES ARE, HOW LITTLE CALCIUM THERE IS PRESENT. IN THE FIRST LEG IN THE ROW NOTE THE WIDE BAND WHICH CONNECTS THE SHANK BONE WITH THE CAP BONE. THIS BAND IS CARTILAGE, NOT BONE, AND WHEN THERE IS SUFFICIENT VITAMIN D AS IN THE TOP ROW THE BAND IS VERY NARROW. WHEN DIET IS DEFICIENT IN VITAMIN D THE BONE DEGENERATES AND CARTILAGE TAKES ITS PLACE. CARTILAGE IS PLIABLE AND UNABLE TO STAND WEIGHT WITHOUT BENDING WHICH EXPLAINS WHY CHILDREN WITH RICKETS BECOME BOW-LEGGED OR DEFORMED

LEG BONES OF RATS THAT RECEIVED THE DIET GIVEN TO THE RAT ON THE RIGHT SHOWN ON PAGE 187. THESE RATS RECEIVED A GREAT EXCESS OF VITAMIN D AND THEIR BONES ARE DARKER THAN THOSE SHOWN IN THE BOTTOM ROW, PAGE 188, BUT NOT AS DARK AS THOSE SHOWN IN THE TOP ROW. THIS SHOWS THAT ALTHOUGH THE VITAMIN WAS PRESENT IT WAS NOT UTILIZABLE BECAUSE OF THE DELETERIOUS EFFECTS PRODUCED BY THE LARGE EXCESS. THE CARTILAGE BAND IS NARROW AND DENOTES ABSENCE OF RICKETS. THE SMALLNESS OF THE BONES, THE DEFICIENCY IN CALCIUM DEPOSITS, AND THE FACT THAT TWO OF THE FOUR RATS PUT ON THE DIET DIED, ARE CONCLUSIVE EVIDENCE THAT EXCESS VITAMIN D HAS ITS PERILS

covered simultaneously that when irradiated with ultraviolet light certain foods developed the potent antirachitic characteristics, the power to cure rickets. Their discovery means that ultraviolet light by some unknown chemical reaction causes the formation of vitamin D in substances in which the antirachitic factor does not exist before irradiation. And, furthermore, it means that proper administration of these irradiated substances encourages normal bone development with the desired formation of calcium and phosphorus, the lack of which is the outstanding characteristic of rickets.

Present knowledge indicates that the distribution of vitamin D in the natural state is comparatively limited. The known natural sources are animal and fish livers, egg yolk, and in a lesser degree butter fat. The liver is the natural storehouse for the vitamins A and D. These facts indicate the importance of the synthetic formation of the antirachitic factor in foods.

The work of Hess and Steenbock at once solved a scientific mystery and opened the door to a new and fertile field for research in nutrition and medicine. Investigations growing out of their work have shown that many foods can be successfully irradiated and experiments on animals and children suffering from rickets have indicated their power to cure. It has also been found that the vitamin content of a food substance lies in the small amount of unsaponifiable solid alcohol which it contains, and that vitamin D is formed by irradiation of this alcohol by ultraviolet light. Most foods containing fat also contain these alcohols, but the vitamin is present only in the alcohol and not in the fatty portion.

Of all the important developments in biochemistry in recent years, none is more striking than the discovery that the sterols, or solid alcohols, are peculiarly adapted for the synthetic formation of vitamin D by ultraviolet irradiation. One of these sterols known as ergosterol has been found to be most susceptible to the effects of radiant energy. Out of this discovery has come the theory that the antirachitic effect produced in man and animals by exposure to ultraviolet light is caused by the formation of vitamin D in or from the natural ergosterol present beneath the skin.

As a result of these discoveries, ergosterol, first derived from ergot, but now obtained chiefly from yeast, is available in irradiated form for medicinal use. Properly irradiated ergosterol is very much more potent in vitamin D than cod liver oil, and is already being widely used by the medical profession in the prevention and treatment of rickets. The commercial form of irradiated ergosterol is called viosterol, a name authorized by the Council on Pharmacy and Chemistry of the American Medical Association. Irradiated ergosterol, it may be noted, does not contain vitamin A, and because of certain dangers attendant upon its unrestricted use, the substance should be administered only by those with a special knowledge of its effects.

RECENTLY there was established in Arizona a remarkable laboratory for the production of irradiated ergosterol by the radiant energy of natural sunlight. A location high in the mountains of Arizona was chosen because the atmosphere in that region is particularly rare, permitting an unusually large amount of ultraviolet rays to penetrate to the earth. The ultraviolet rays of natural sunlight are utilized in this unique laboratory by means of large parabolic reflectors in which the available light is concentrated at the focal point. Ergosterol dissolved in ether courses through this focal point in quartz tubes during the process of irradiation. By this method ergosterol with a vitamin D potency of some 10,000,000 rat units per gram is produced at a cost said to be very low in comparison with artificial methods of irradiation.

As a result of his discoveries in the irradiation of foods, Dr. Steenbock's process was patented and its application to commercial foods is now controlled by special license. Administration of the rights to use this process for foods and medicine is vested in the Wisconsin Alumni Research Foundation, an organization of the University of Wisconsin, to which the profits accrue. Several manufacturers, including a company which sells cereal foods, and another which produces yeast, are irradiating their products by the Steenbock process.

Early in the investigations on the irradiation of foods Steenbock and his colleagues worked out a complete irradiated diet which cured rickets in rats, and found proof that even normal babies could have their calcium retention increased by feeding them irradiated olive oil.

Dr. Amy Daniels, of the State University of Iowa, found that irradiated milk and irradiated olive oil were both more effective than cod liver oil, and Dr. Hess

demonstrated that irradiated cottonseed and linseed oils were as effective as cod liver oil in curing rickets in rats.

Out of these early experiments have come a long list of foods that can be successfully irradiated. Most animal and vegetable food materials which contain oils have present in them the solid alcohols in which vitamin D is produced upon irradiation. Among these are corn, coconut, and peanut oils, lard, oleomargarine, and butter. Mineral oil, however, cannot be activated because it contains no substances in which vitamin D can be formed by irradiation. The cereals include refined wheat flour, whole wheat flour, wheat cereals in other forms, oatmeal, corn meal, and corn starch. Meat, milk, whole or dry, various vegetables, and orange juice also can be irradiated to great advantage. The vitamin potency of egg yolk was increased from 10 to 20 times by exposing hens to ultraviolet light.

Considering the short time since its discovery, great strides have been made in the development and production of vitamin D by synthetic means. Up to this time little is yet known about how the antirachitic vitamin works in the mysterious process of bone development. No precise method for the measurement of the quantity of the vitamin is yet known. The rat unit of the laboratory worker, itself accurate only to 10 or 20%, is the accepted standard at present. This unit was arrived at as the result of experience in research with thousands of generations of the standard white rat, which lives 30 times faster than man. The rat unit is defined as that amount of vitamin D which, when uniformly distributed in the standard vitamin D deficient diet, will produce a narrow and continuous line of calcium deposits in the distal ends of the radii and ulnae (knee) bones of rachitic rats.

With the exception of milk, comparatively few experiments with irradiated foods have been carried on with children. The outstanding need at present is an accumulation of evidence on which to base sound judgment in this new field of nutrition. That evidence will have to come more from clinical than from laboratory experience, since it is doubtful that feeding experiments with animals can be carried over accurately to the human being.

Because of its universal use as a food, and as the chief source of calcium in human diet, it is quite natural that much attention is being devoted to research in the irradiation of milk, which in its natural state is low in antirachitic potency.

At the present stage of research the methods being used in attempts to increase the antirachitic potency of milk are: (1) direct radiation of lactating animals, (2) irradiation of the milk, (3) addition of substances rich in vitamin D to the diet of the animal.

Dr. Steenbock has irradiated cows to determine whether exposure to ultraviolet light has any effect in increasing lactation or developing greater antirachitic potency in the milk. With the exception of a slight increase in the vitamin D content and the quantity of milk produced, the effect on dairy cows was disappointing. The same experiments on lactating goats, however, brought striking results.

Irradiation of human mothers has produced varying results. In some instances the antirachitic potency of the milk, which naturally is low in vitamin D, was increased slightly. Other experiments were less encouraging.

Studies in the direct irradiation of milk have shown most encouraging results. Dr. Steenbock has increased the antirachitic potency of cow's milk eight, and goat's milk 20 times by irradiation under a mercury arc lamp. Dr. Hess has shown that infantile rickets can be cured by irradiated milk, and other distinguished workers have had similar encouraging results. This method at present is used most generally in Germany where various cities are already supplying irradiated milk for the treatment of rickets. In Germany no less than five methods of direct irradiation of milk have been developed, and in England much important work has been done in the prevention and treatment of rickets by this means.

The vitamin potency of yeast is greatly increased by irradiation, and the ordinary cake so processed contains a minimum of 18 rat units, which is equivalent to slightly more than one unit per gram. Striking results in the treatment of rickets in babies by adding irradiated yeast to their milk diet have been obtained by workers in the State Institute of Hygiene at Warsaw. The babies thrived on the treatment, rapid healing of rickets ensued, and the small charges became energetic and playful in contrast to their earlier listless and downcast condition.

The addition of substances rich in vitamin D to the diet of cows and poultry is being studied with the hope that this method will result in increased antirachitic activity in milk and eggs. Early investigations on cows fed with irradiated hay or cod liver oil produced unimportant results, but recent experiments in adding irradiated yeast to their diet produced a marked increase in the vitamin D content of the milk.

The full significance of irradiated foods awaits the development of more complete knowledge of their effects, as well as new standards of measurement. The process at present may be complicated by the various reactions produced in different substances by ultraviolet radiations. These effects under certain conditions cause destruction of the enzymes, the active principles of serums, bacteria, other vitamins, and may produce coagulation of proteins and bleaching of pigments. Irradiation may also make food unpalatable. Such effects, however, are usually the result of irradiation in excess of the amount necessary to produce antirachitic potency. Recent experiments have shown that irradiation of cow's milk for even eight seconds increased the vitamin D activity nine times, reduced bacteria 10%, and caused no undesirable effect upon the vitamin A content.

Granted that the vitamin D is beneficial for the adult, as well as in the treatment of disease in infants, authorities in this new science believe that adults of the Western Hemisphere, at least, probably get a sufficiency of the antirachitic vitamin in their daily foods (note illustrations and their captions). In such countries as China, where the national diet is restricted to a narrow group of basic substances, chiefly cereals, the addition of vitamin D might prove valuable.

No one will deny the far-reaching possibilities revealed by the discovery of vitamin D and methods for producing it, but the complete answer to the question of the part it will play in public health still lies in the unfathomable future. Until that answer is given in clear and unmistakable terms the public should seek the judgment of experts before using irradiated substances.

THE TREND OF AFFAIRS

Alchemy in Old New England

THREE hundred years ago this year, the John Winthrops, father and son, came to Boston. The elder John Winthrop became the second governor of the Massachusetts Bay Colony, and the younger in due course became the first governor of Connecticut. In connection with the celebration last year of the tercentenary of Boston, we have heard of their importance in the political and social life of the young colony. They also gave economic life to New England, especially the younger Winthrop who was alchemist, chemist, physician, and the first manufacturing chemist and practical technologist in the English colonies of North America.

John Winthrop, Jr., imported chemicals and laboratory apparatus from England in 1633. In 1643 he began the manufacture of iron at Lynn and at Braintree and, in 1648, he was granted a commission by the General Court of Massachusetts to manufacture salt. Two years later he planned a chemical stock company, the first in America, for the manufacture of saltpeter, and in the year afterward was granted by Connecticut the first monopoly for the working of lead, copper, tin, antimony, vitriol, alum, and other materials. He also started the manufacture of glass. In 1662, during a trip to England, he read before the Royal Society a paper on the manufacture of tar in New England, and in the following year carried out for the Royal Society experiments on the brewing of beer from maize. He was a famous practitioner of medicine, and made use of chemical remedies which he prepared himself.

He was a member of the Royal Society, and a friend and correspondent of Robert Boyle, Kenelm Digby, and other men of science in England. In his large library there were many books devoted to chemistry and medicine, and also a number of alchemical books which had formerly belonged to Dr. John Dee, the physician of Queen Elizabeth. Many of his books, manuscripts, and letters are preserved at Boston today in the library of the Massachusetts Historical Society. He died at Boston, and is buried in the same tomb with his father in the churchyard of King's Chapel.

Courtesy Massachusetts Historical Society

JOHN WINTHROP THE YOUNGER. HE BROUGHT ALCHEMY TO AMERICA

Winthrop's friend, George Stirk or Starkey, was the most famous of American alchemists. The son of a Bermuda clergyman, he came to Harvard for his education and graduated in 1646. He practiced medicine in Cambridge or Boston in 1647, and was established in Boston in 1648–1650. Later he went to England. His pills and his oil of sulphur were well-known nostrums, and his alchemical writings, issued in part under his own name and in part under the pseudonym of Eirenaeus Philalethes, were long held in high repute by the adepts. He claimed to have discovered the secret of transmutation in 1645, and actually convinced a number of reputable persons that he had done so. He died of the plague at London in 1665, according to one account while in prison for his debts, according to another because he dissected the body of a plague victim.

Interest in alchemy was prevalent in the New England colonies. In 1657 Jonathan Brewster, the son of Elder Brewster of Plymouth Colony, was carrying on the search for the Grand Arcanum in a cabin at the trading post of Manheken (Monhegan), afterwards a part of Norwich, Conn. He wrote to John Winthrop, Jr., telling of his experiments in the preparation of the red and white Elixirs and of his doubts of their successful outcome. William Avery was seeking for the alkahest at Boston in 1684 and had taught his son, Jonathan, to be "an assiduous laborer at the chemical fire," as is attested by his letters to Robert Boyle. Other later alchemists were Judge Danforth, Dr. Aeneas Munson, and President Ezra Stiles of Yale, the last-named being comtemporary with the American Revolution.

Widia, Sire of Carboloy, or Another Adventure of the Metallurgists

HEPHÆSTUS was the ancients' god of fire, one of the ten "great gods," and the finest artificer in metal among them. In latter days he went somewhat into eclipse, but now we find him again in the ascendency and we hasten to limn the achievements of his protégés, the metallurgists. One of these, Dr. Robert S. Williams, '02, of the Institute's Department of Mining Engineering and Metallurgy, has

told the story of "carboloy" and we pass along this tale of another feat accomplished by these men who work with metals.

A few years ago a small amount of a cutting material came into this country from Germany. It was known as "widia" and while it had some remarkable properties, attracted surprisingly little attention. Some three years ago the General Electric Company became interested in this new material because of troubles in their own machine shop using well-known cutting steels. The investigation and development of this material was taken over by a number of members of the Schenectady research staff under the direction of Dr. S. L. Hoyt and, as a result, a greatly improved material is now available under the name "carboloy."

This material is essentially an alloy of the very hard abrasive material, tungsten carbide, the fine particles of which are cemented together with metallic cobalt. It is not a true alloy in the sense that it is not produced as a result of melting, but it is made by sintering the carbide at high temperatures and under heavy pressures with cobalt as a binding material. Many other companies are now manufacturing a similar material although the great interest in this new cutting material has been stimulated almost wholly by the researches and publications of the General Electric Company.

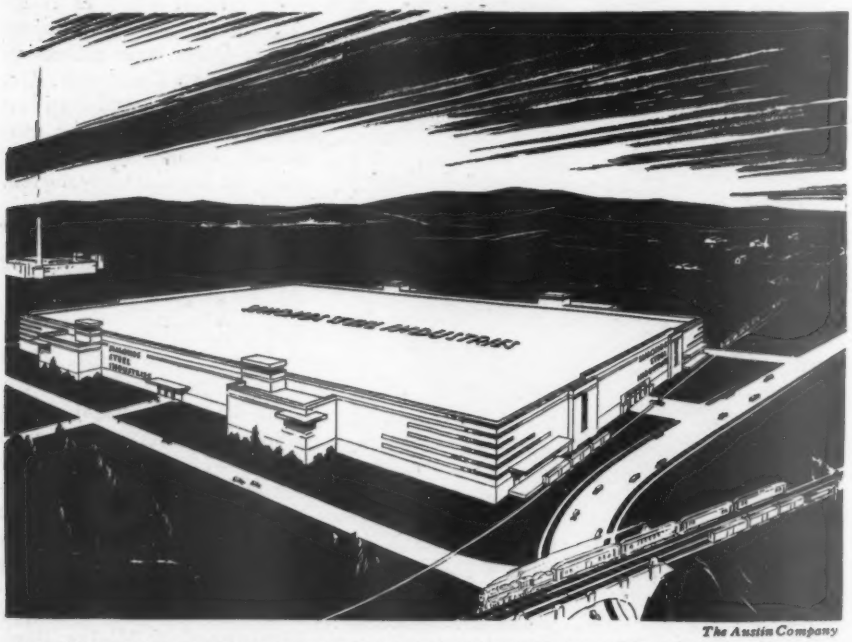
Carboloy looks like tool steel and has about half its tensile strength. It is so much harder, however, than any tool steel now known that it will do many things that were formerly believed to be impossible. With it, for example, porcelain can be cut, glass tubes can be threaded. Dr. Hoyt has even succeeded in machining threads on sapphires.

In cutting off steel with the usual cutting material, about 100 cuts could be made before the tool had to be re-sharpened. With carboloy 15,000 cuts have been made on the same material and of the same dimensions before re-grinding became necessary. With ordinary automatic cutting tools a four and a half inch hole was made in cast iron and the tool needed to be ground after about 100 holes had been made. With carboloy nearly 1,000 holes can be machined before grinding is necessary. A bronze bushing was bored with a tolerance of 5/10,000 of an inch. The old record was 150 bushings before re-grinding was necessary; with carboloy the number of bushings made has been increased to 7,000. These examples will illustrate the advantage of the use of this new alloy for special purposes.

It has, however, several disadvantages, the greatest of which is perhaps its brittleness. On account of this quality the tools are specially designed and the machines used with carboloy must be heavily constructed so that the minimum amount of vibration occurs during the machining operation. For the last few years carboloy has commanded the high figure of $450 a pound. This price, however, has been materially reduced during the last few months and it will be sold at a still lower figure in the near future.

The outstanding uses of carboloy are probably found in the field of cutting of abrasive materials, as, for examples, the insulating material used in the electrical industry, asbestos, wood, ivory, and other substances that are not necessarily extremely hard but are so abrasive that an ordinary cutting tool loses its sharp edge in a short time. The manufacturers do not feel that these tungsten carbide tools will displace the older types of cutting steels, but they believe that for certain special uses carboloy will prove an invaluable material.

Certainly it is the greatest contribution to machine tool processes since Taylor and White at the close of the last century made their great study for the Bethlehem Steel Company whereby the company's machine shop output was increased more than 500%.



The Austin Company

FACTORY WITHOUT WINDOWS, TO BE ARTIFICIALLY ILLUMINATED AND VENTILATED. THE SIMONDS SAW & STEEL COMPANY, FITCHBURG, MASS.

Claustrophobia or Utopia?*

IT IS a far cry from California to Massachusetts, and there is a notable difference between a moving picture and a saw. Yet it is because of experience gained in erecting talking picture studios in California that the Austin Company of Cleveland was selected to build the new windowless factory of the Simonds Saw and Steel Company in Fitchburg, Mass.

The outcome of this seminal experiment will be carefully watched. The greatest

* The dread of being in an enclosed place. Allied words are: *batophobia* — morbid dread of high objects or of being at a great height (*acrophobia*); *agoraphobia* — dread of crossing, or of being in the midst of, open spaces.

unknown factor is the psychological effect on the workmen of these unusual factory surroundings. Will they result in claustrophobia? The American workman is conservative in many ways, and may dislike the sense of isolation from the outside world and what may become deadly monotony under even perfect working conditions. It may, however, be a great boon not to have to look out upon the unlovely purlieus of that city.

The saw company is erecting this new type of factory because it believes that by controlling the conditions under which its employees will work so that they will be uniform throughout each day and night in the year, and conducive in every way to the comfort and ease of the individual worker, the efficiency of that worker will be increased by at least 30%. Everything that will affect any of the five senses unpleasantly will, as far as possible, be eliminated.

STUDY IN THE ANATOMY OF A LOCOMOTIVE

The factory will be a silent place, or at least be as quiet as it can be made by noise-eliminating devices. The walls will be constructed to absorb, not to reflect or transmit, sound. The machines will be mounted on blocks of cork, and will be so shielded that any sound waves originating from them will be broken up. Noises from materials in process of manufacture will be reduced by causing those of similar frequency to counteract each other. It is hoped that it will be possible to carry on a conversation in an ordinary tone, even in close proximity to the moving machines.

In any building lighted by daylight, the intensity of the light is constantly changing, and there is a constant strain on the eye muscles and the optic nerve in the attempt to compensate for this change; this is an important cause of fatigue. Such direct sunlight as falls on windows or skylights contains, it is true, the beneficial ultraviolet rays, but these are removed by window glass.

In this windowless building, lighting will be from 1,000-watt electric lamps, placed 18 feet above the floor, and enclosed in special diffusing shades. These will furnish a density of illumination of 20 foot-candles at the working plane, which will be conducive to accurate and quick vision. A certain proportion of ultraviolet light will be introduced, but this presents a real problem because of the meagre knowledge of the necessary health rays and the limited methods for artificially producing them. Failure of the power source is provided for by a stand-by storage battery.

The air in the factory will be washed as it enters the building; it will be heated in cold weather and cooled by a spray in hot weather. The temperature will be kept constant. By a series of baffles, drafts will be eliminated.

The well-known psychological effect of color in depressing or exalting human beings is made the basis for a decorative scheme. Blue, green, and white have been chosen for the walls and ceiling. The machines will be painted a brilliant orange, thus increasing the visibility of the moving parts, to reduce accidents. The machines are arranged for straight-line production, and handling is reduced to a minimum. Everything is planned to eliminate fatigue due to unnecessary motions, and every comfort and convenience for the workers is provided. The rest rooms will have fittings similar to those in the better class of hotels.

Should this experiment prove successful, if the expected increase in efficiency is attained, and the two-shift system results in the reduction in overhead, we may see radical changes, not only in factory buildings, but in whole industrial communities. This factory is to cover the area of two ordinary city blocks and there seems to be no really important technical reason why it should not cover two square miles. It is possible that we may yet see whole industrial cities without windows, and without open streets.

Streets serve two useful purposes; they furnish openings to the sky, through which daylight may reach the windows of adjacent buildings; and they furnish space for the agencies of transportation. But they also give noise, dirt, and dust, and at times a slippery surface covered with sleet, snow, or slush.

That a street can be maintained in a clean, well-lighted, and ventilated condition if only it be covered, is evidenced by the Hudson Vehicular Tunnels. These are, after all, only underground streets. A street can just as well be within a building, if the building is windowless. It can be underneath, or on any floor. The roof, of course, would be reserved for airplanes. Railroads, moving sidewalks, and stairways, and ramps for motor vehicles could be provided for. Signaling systems would function without interference.

Of course, windowless buildings are not really new in principle. Whole floors in the Grand Central Station and the adjacent hotels are windowless. Nearly every skyscraper in New York has basement floors which are practically isolated from daylight, and there are miles of underground streets or passages. A windowless building or city is unique only because it has been planned to be that way.

Prolegomena on the Uses of Water Gas

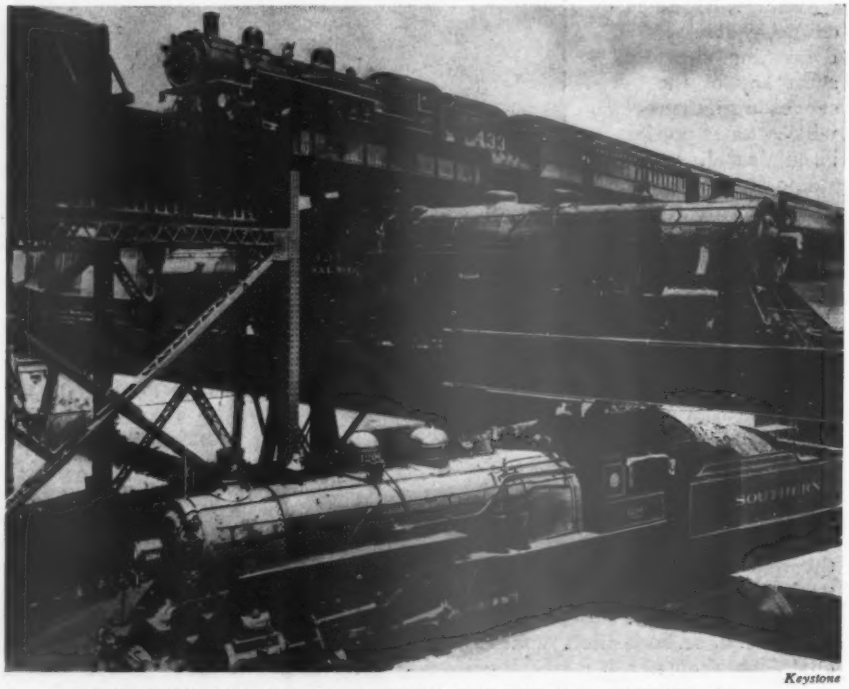
HIGH pressure *per se* may not be of great significance to the layman, but if he be an observant layman, he will soon discover that high pressure eventually will mean something to him, perhaps in terms of such mundane things as cheaper prices for staple products. Certainly the industrial chemist values it highly. By its use he has been enabled to do such things as to make a gallon of gasoline from a gallon of oil (hydrogenation), to synthesize ammonia (the Haber process), and to utilize water gas for the synthetic production of methanol. There is no chemical reason why these accomplishments may not be extended to include the synthetic manufacture of coal tar products.

The industrialist will quickly realize what high pressure means to him when it is suggested that the following products may in the future be manufactured by adding hydrogen to water gas under high pressure:

1. dye-stuffs
2. synthetic silk, more like genuine silk than rayon
3. synthetic fats and proteins.

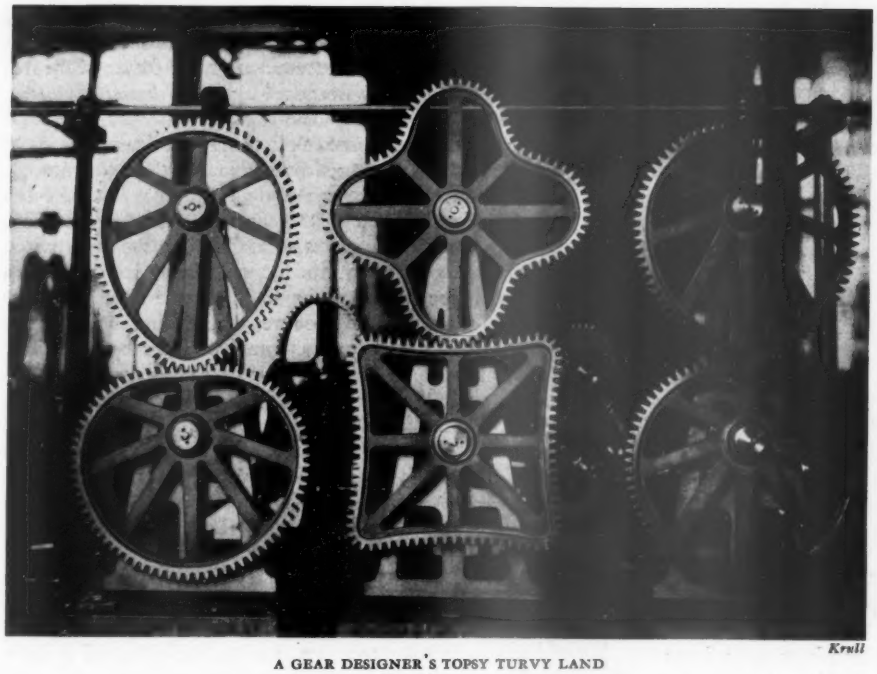
The winner of the 1930 Grasselli Medal of the Society of Chemical Industry, Dr. Per K. Frolich, '23, has recently pointed out that "in pressure the chemist has discovered a tool with which he is now rapidly opening up a new field of industrial activity. As a means of short-cutting the traditional step-by-step methods of organic chemistry pressure seems to offer remarkable opportunities. The ancient barrier between aliphatic and aromatic chemistry has been broken down by pressure. This being so, are we not justified in concluding that the chemical industry of the future will have other sources than coal tar from which to obtain its raw materials for dye-stuffs and numerous other aromatic derivatives?"

Dr. Frolich is well qualified to speak upon the prospects for the use of high pressure in synthesizing products, for it was because of his contribution to this new



Keystone

PILING PELION UPON OSSA: THREE-WAY RAILROAD CROSSING IN RICHMOND, VA.



A GEAR DESIGNER'S TOPSY TURVY LAND *Krull*

chemical technique that he was awarded the Grasselli Medal. He has been extraordinarily successful in developing a procedure for testing catalysts for high pressure reactions, and it is not too much to say that today his method must form the basis for any research program on high pressure catalysis. His work was carried out in the Institute's Research Laboratory of Applied Chemistry and is but another demonstration of how research eventually makes itself felt by the man in the street.

Bargain Counter Transportation

TRAFFIC is, paradoxically, both a cause and effect of the serious attention being accorded city planning today. Its exasperations provoke public clamor for remedial measures and these, in turn, take form as bigger and better subways, bridges, widened streets, vehicle tunnels, and an enhancement of the commuting habit. The last-named weighs heavily on the railroads, particularly in the larger centers where the private automobile affords neither a comfortable nor an expeditious form of residence-office transport.

In New York the apotheosis of underground and under-river tube boring, overhead trains and highways, the Transit Commission estimates that the number of commuters entering the city each working day has risen 55% in the five years from 1925 to 1929. The figure for the latter year was 568,420 and the majority came by rail.

Seemingly, in a time when the railroads are bending every effort to woo back passenger business, a mounting army of commuters would be a welcome proposition. Not so, however, for a commuter rides on some varying form of reduced fare ticket. He pays on an average of less than a cent plus a mill per mile as compared with the average established rate of 3.6 cents per mile. So it is that, though the bulk of the commutation customers of the United States are confined to six urban areas — New York, Chicago, Philadelphia, Pittsburgh, Boston, and San Francisco — and though the records of the Interstate Commerce Commission show 57% of the 779 million passengers carried on all the country's railways in 1929 were commuters, they contributed but 8.5% of the 872 million dollars of the total passenger revenue.

The problem in New York can be appreciated by the latest twelve-month figures which show the Long Island Railroad as carrying 85 million commutation passengers, the New York Central 44.5, the Erie 31, the Lackawanna 22.6 and the New Haven 18.3. Other roads account for nearly 30 million. The New York Central's commuter business has nearly quadrupled in the last 20 years and now comprises 65% of its passenger traffic flowing through the Grand Central Terminal. This 65% yields, however, but 8% of the passenger revenue.

Both the New York Central and the Lackawanna are contending for higher fares and there is much talk of the unfairness of railroads being required to maintain private rights-of-way and pay heavy taxes thereon while public monies are being used to provide highway and vehicle tunnel facilities for competitors. Data showing that 11,912,869 vehicles (including many buses carrying commuters) passed through the Holland Tunnel during the year ending October 31, 1930, are cited as an illustration.

Commuters are not always served at a dead loss, however. The Illinois Central modernized and electrified in 1926 and, in 1929, carried 36 millions at a profit of $1,516,000 as contrasted with a loss of $645,000 on 24 millions in 1925. The Chicago and Northwestern's suburban service, which is not electrified, is said to be breaking even. It affords an idea of Chicago's North Shore commuter-load for, between 5 and 6 p.m., it operates 43 trains carrying 22,000 homeward.

One can readily deduce from the foregoing that the trunk lines have no very great interest in building up commuter traffic. It crowds terminals already bursting, complicates train despatching, fades away on Sundays and holidays and complicates the smoothness of things generally. Yet, like it or not, the railroads find it on their doorstep to stay and it is the one form of passenger traffic which is holding its own in the face of all sorts of competition.

Possibly an answer is to be found by cutting operating costs, by electrification, by providing more efficient terminal facilities, or by a combination of all three. Last autumn the Pennsylvania placed in operation in the

business center of Philadelphia adjacent to its Broad Street station, a fully electrified suburban passenger terminal which exceeds in size and scope any similar facility in the country. It is to handle 325 daily trains and its operation will be closely watched by the Pennsylvania.

Certainly, if the railroads can get the commuter problem out of the red by some means other than rate raising, they will feel relieved. To attempt rate-raising on commutation tickets, as they have learned from experience, not only means trouble with regulating bodies, but it upsets real estate values and family budgets and, thus solidifying public opinion, provokes another "of those periodical struggles which keep life in the suburbs from becoming too dull."

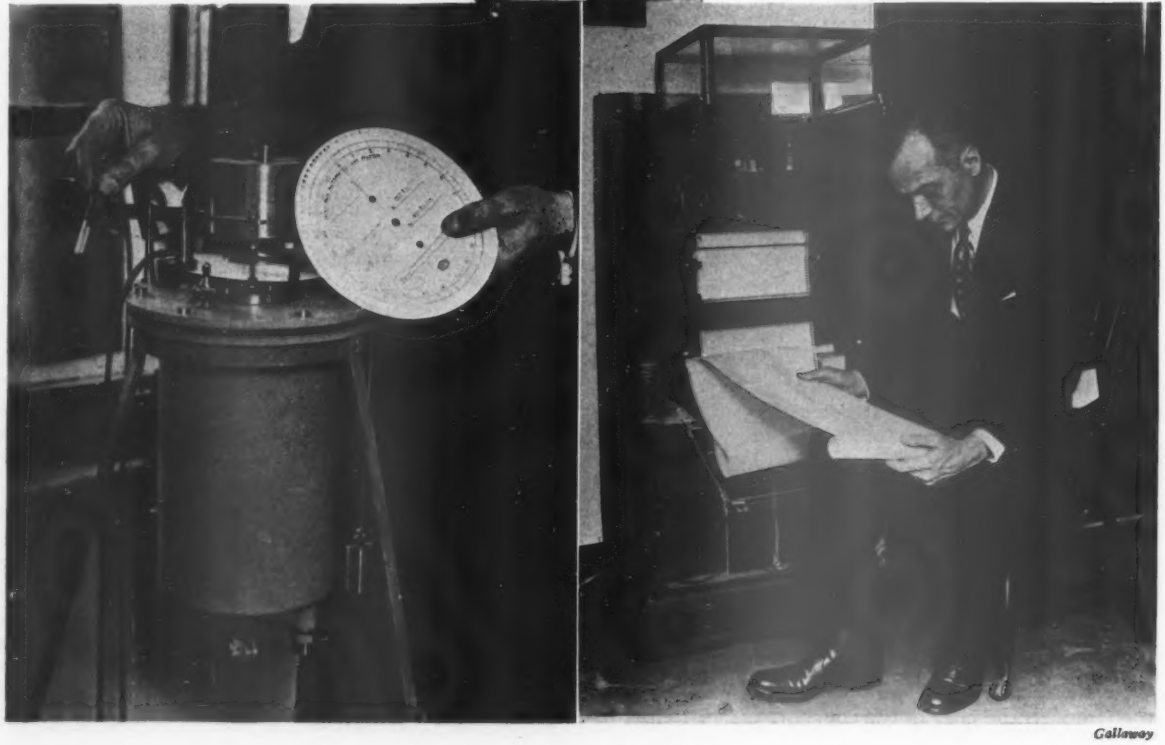
Set a Disease to catch a Disease

ONE of the striking paradoxes of medicine in recent years is that malaria, which has taken innumerable lives and wrecked countless others, has a therapeutic value in the treatment of certain forms of insanity. The discovery was made by W. Jauregg, a psychiatrist of Vienna, who, in 1917, observed that certain chronic mental conditions improved after attacks of malaria.

Deliberate infection with germs from mosquitoes artificially infected with blood from a malaria patient, has produced definite improvement in cases of *dementia paralytica*. Further investigations of the part that malaria may play in treatment of other forms of mental disease, including *cerebrospinal syphilis*, *dementia praecox*, *confusional insanity*, and *encephalitis lethargica*, are now being made. Time alone can determine the permanence of the cures already effected by the malarial treatment.

These developments come some 300 years after the discovery of quinine, and 50 years after the identification of the germ that causes malaria. Quinine, the drug which today stands as the specific for malaria, is derived from a Peruvian tree called cinchona. The name is said to have derived from that of Countess Cinchona, wife of the Viceroy of Peru, who was cured of fever by the bitter juices of its bark. Legend has it that the countess' physician, one del Vigo, was told of the curative value of the bark by Peruvian natives, who are believed to have used it for malaria long before it was known to the white man. Cinchona is credited with its appearance in Europe. It was not until 1880, however, that Alphonze Laveran discovered the malaria germ.

Long after its discovery cinchona bark was exploited by charlatans as a remedy with secret powers for miraculous cures. Its use in the form of quinine advanced steadily under scientific control, and today quinine and sanitation are the chief methods of control for malaria.



THE BATTLE AGAINST SMOKE. BELOW: APPARATUS USED BY NEW YORK METEOROLOGICAL OBSERVATORY TO OBSERVE POLLUTION IN THE AIR. LOWER RIGHT: AN ELECTRIC EYE ON THE ROOF OF A BUILDING CONNECTS WITH THIS RECORDING DEVICE TO GIVE A GRAPHIC RECORD OF THE AMOUNT OF SMOKE IN THE AIR

LEFT: UMBRASCOPE WITH ITS SERIES OF LENSES USED TO GAUGE THE DENSITY OF SMOKE POLLUTION. THE COST OF SMOKE POLLUTION IN NEW YORK IS ESTIMATED TO BE $16.00 PER CAPITA

Galloway

Pharology

IN the world of the mariner the Nantucket lightship holds a high place as one of the most important beacons in the seaways of the globe. Riding 41 miles off the New England coast and farther from shore than any other lightship, it warns transatlantic traffic of the dangerous Great South Shoals and it serves as a reference point by which navigators plot their courses. Such an important navigation aid requires the best possible equipment and the Department of Commerce, by ordering the construction of a new lightship carrying a crew of 16 and every modern signaling device, has recognized the need.

This latest refinement of lightship design calls attention to the story of man's long efforts to make the sea safer for sailors. Pharology, the science of lighthouse construction probably originated in Egypt, for the earliest beacons were built by the Libyans and Cushites in lower Egypt where priests maintained great fires to aid navigators. Lesches, the Greek poet, mentioned a lighthouse as early as 660 B.C. at Sigeum, now Cape Incihisari, in the Troad. Perhaps the most famous of the earlier lighthouses and the one which supplied the name for the science of lighthouse building was the great Pharos of Alexandria, built by Sostratus of Cnidus in the reign of Ptolemy II. Legend has it that this great tower lifted its spire to the height of 600 feet, but historians have found little evidence of such a height.

The next great lighthouse builders were the Romans. Examples of their art include the famous tower at Ostra, built by the Emperor Claudius about 50 A.D., and the lighthouses at Ravenna, Pozzusli, and Messina. The earliest lighthouses in western Europe were built by the Romans at Dover and Boulogne. The light of Cordouan, perched on a rock in the sea at the mouth of the Gironde River, is the first example extant of a wave-swept tower. Two earlier towers are said to have stood on the site now occupied by the present one, started in 1584 during the reign of Henry II of France, and completed in 1611. The upper section of this splendid Renaissance tower was removed near the end of the Eighteenth Century to be replaced by a loftier structure at a height of 207 feet. Until then the light in this beacon was a fire of oak logs. Later coal was burned.

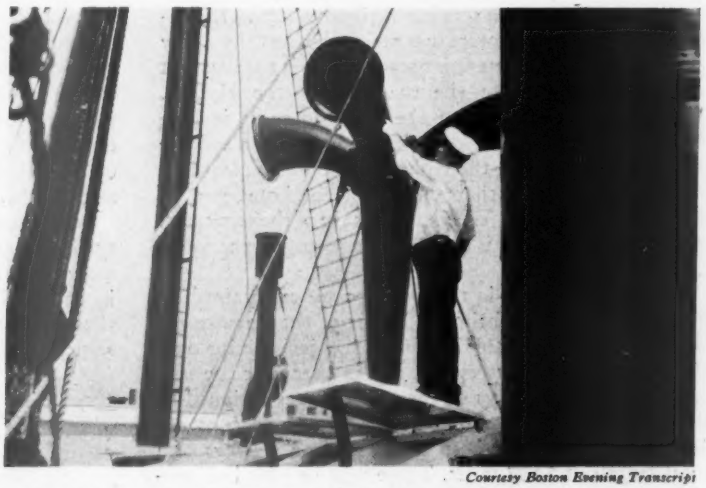
Up to the end of the century the lighthouses of Great Britain and the United States were of inferior construction to those of other countries having important coastwise shipping. Many of the earlier lights on the coast of England and Scotland were privately owned towers, in the summits of which wood or coal was burned in huge grates or chauffers. Coal lights were in use on the Scottish coast as late as 1816, in England until 1822, and in the Baltic until 1846. The use of oil then came into favor marking the era of light without smoke, for in those earlier lights billowing smoke often entirely obscured the light of the fires.

The father of Robert Louis Stevenson, Thomas Stevenson, a distinguished civil engineer of his day and an authority on lighthouse construction and equipment, made important improvements in the lens systems of the lights in use about 1870. His volume on "Lighthouse Illumination," published in 1871, was considered a distinguished contribution to the engineering literature of the day. Scotch engineers, and particularly the Stevenson clan, seem to have had great influence in lighthouse engineering, for the records make full acknowledgment to the genius of Alan, Robert, Charles, and D. Stevenson, as well as Thomas.

Robert Louis Stevenson planned to follow in the profession of his father and began his engineering education in 1868. Later he was awarded the Silver Medal of the Edinburgh Society of Arts for a notable paper on lighthouse apparatus. As his delicate health could not stand the rigors of an engineer's life, he retired to study law.

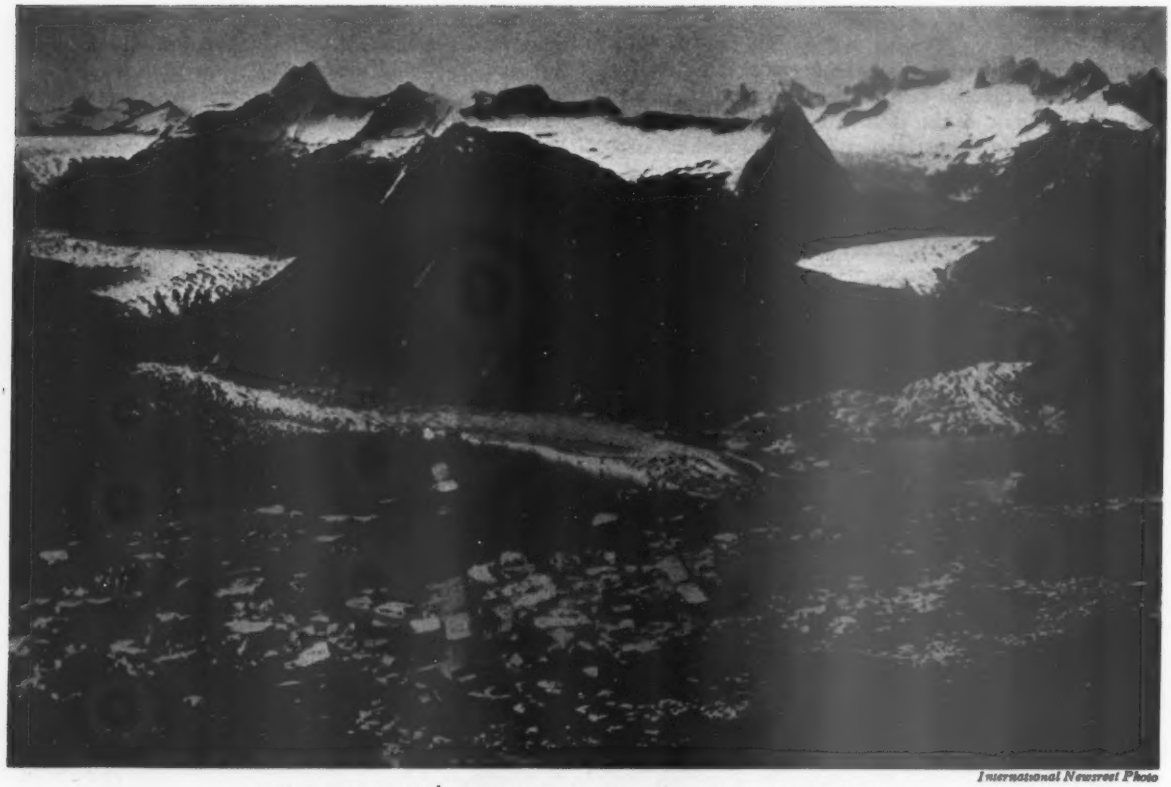
In the world of lighthouses, Eddystone Light is probably most famous. Due to the hazards of its location near the entrance to the English Channel on the sinister Eddystone Rocks in Plymouth Sound, it had to be rebuilt four times. The first tower was built in 1698 by Henry Winstanley, who was given to grotesque architectural decorations with no bearing on lighthouse construction. Utterly confident of his design, he later saw his handiwork crash into the sea during a heavy storm. The second tower, strange as it may seem, was built by a London silk merchant named John Rudyerd. He attempted to build a wooden tower, circular in form, whereas the first tower had been an irregular polygon. This tower withstood the great storms of the English Channel for 46 years and was finally destroyed by fire.

The most famous of the Eddystone Lighthouses and the one which preceded the present structure, was built by John Smeaton, instrument maker of London (see page 201). After a severe storm, he went into the forest and studied the trunk of a sturdy oak that had survived the gale while all the other trees had fallen. From this observation he came to the conclusion that there must be great weight in a small mass and that the tower must be fireproof. Accordingly, he designed his famous tower to be constructed in stone, each piece dovetailed into the



Courtesy Boston Evening Transcript

FOG SIGNAL USED ON NEW DIESEL ELECTRIC LIGHTSHIPS FOR U. S. COASTS. THE SOUNDING MECHANISM IS OPERATED BY COMPRESSED AIR



International Newsreel Photo

PLANES OF THE NAVY'S ALASKAN AERIAL SURVEY OVER TWIN GLACIER LAKES

other in a most involved pattern. The light shone from the completed structure for the first time on the night of October 16, 1759. The present tower replaced Smeaton's well known work in 1882.

The first act of Congress providing for lighthouses was passed in 1789 and the original Boston light on Little Brewster Island at the entrance to Boston Harbor is reputed to have been the first lighthouse built in America. Constructed long before Congress officially recognized lighthouses, it has been serving navigators from 1716 until today. The first structure was replaced in 1859 by a new tower and the light from this second tower is the one that now guides ships into the roads of Boston Harbor. Other early lighthouses on the Atlantic coast include Beaver Tail at the entrance to Newport Harbor and the Brant Light for which the whaling captains of Nantucket's famous fleet laid their course for the home port of that salty little island. The first lightship of the territorial waters of this country is said to have swung at anchor in Chesapeake Bay.

Aids to navigation in this country are maintained by the United States Lighthouse Service of the Department of Commerce. Until 1926 this bureau had jurisdiction over all beacons on the waterways, and in that year the task of marking the airways of the country was assigned to the lighthouse service. Since then, 1,275 beacons for aerial navigators have been established on airways of a total length of 5,877 miles. These will be added to constantly as the need arises until all important celestial courses are marked. The standard airway beacon shows a revolving beam of light of 2,000,000 candlepower, and there are various auxiliary lights and course markers to aid aviators in charting their courses from city to city from the Atlantic to the Pacific, as well as north to Canada and south to the Rio Grande.

The lens equipment of lighthouses and land beacons has been improved constantly and the apparatus now in use represents the most advanced knowledge of optics. The great lighthouses of the world are still maintained by men who are isolated for months at a time. At one time lighthouse facilities were cold and barren. Now most of them offer the average comforts of life. It is probable that the lighthouses of the future will send their beams to the watchful navigator without the aid of a human attendant, for the photo-electric cell may be adapted to extinguish the light at dawn and to set it revolving again at twilight.

Be that as it may, lighthouses will always remain a symbol of man's courageous struggle to conquer the elements. Sir Walter Scott when visiting the Bell Rock light in Scotland sat down and wrote in the visitor's book there a stanza (*Pharos Loquitur*) which captures the romance of the Pharos:

"Far in the bosom of the deep,
O'er these wild shelves my watch I keep,
A ruddy gem of changeful light,
Bound on the dusky brow of night,
The seaman bids my lustre hail,
And scorns to strike his timorous sail."

BOOKS

Scientific Book Club Selections

BY special arrangement with the Scientific Book Club, Inc., the Review is to present each month the books selected by that body as meriting the careful attention of all who desire to keep abreast of scientific thought. The selections are made by an editorial committee consisting of Arthur H. Compton, Edwin G. Conklin, Kirtley F. Mather, Harlan T. Stetson, and Edward L. Thorndike.

For December the principal selection was:

FLIGHTS FROM CHAOS, by Harlow Shapley. $2.50. 170 pages. Illustrated. New York: *The Scientific Book Club, Inc.*

" . . . a survey of material systems from atoms to galaxies. Orientation in the physical world is its guiding ambition — orientation and stimulus. 'The survey has been developed in order to show to what extent a unified classification of all known material systems can be devised; to provide practical subdivisions for several classes; to find the relation of our galactic system to external galaxies; to emphasize the importance of the substratum of particles, gas, and radiation that constitute the Cosmoplasma; to sort out into appropriate categories such undifferentiated objects as gaseous nebulae; and to mark the place of organisms in the cosmic scheme.'"

Other highly recommended books obtainable from the S.B.C. are:

DEMONS OF THE DUST, by William Morton Wheeler. $5.00. 362 pages. Illustrated.

THE PROMISE OF YOUTH, by Barbara Burks, Dortha W. Jensen, Lewis M. Terman and others. $6.00. 508 pages.

LIVING AFRICA — WANDERINGS OF A GEOLOGIST, by Bailey Willis. $4.00. 313 pages. Illustrated.

LITTLE AMERICA, by Richard E. Byrd. $5.00. 412 pages. Illustrated.

THIS THING CALLED BROADCASTING, by Alfred Goldsmith and Austin Lescarboura. $3.50. 362 pages. Illustrated.

MAN AND THE STARS, by Harlan T. Stetson. $2.50. 221 pages. Illustrated.

The Philosophy of Modern Science

THE MYSTERIOUS UNIVERSE, by Sir James Jeans. $2.25. ix+163 pages. New York: *The Macmillan Company.*

IN the first of his books for the layman, "The Universe Around Us," Dr. Jeans gave an accurate but simple non-mathematical account of the results of modern astronomical and physical research. Although his present book, "The Mysterious Universe," may be regarded as a sequel to this, it is quite complete in itself. In it he attempts to show in what way these results may influence modern philosophical thought. In the first four chapters there is a discussion of those scientific questions which influence our outlook and ideas of the universe as a whole and our relation to it.

Beginning with an exposition of the vastness of space and the extremes of temperature ordinarily encountered, the almost inconceivable rarity in this universe of organic life as we know it is emphasized. We find that the universe, far from seeming to be designed to support life, is either indifferent or actually hostile towards life. In fact the probability is so very large that at the present time it is only in our solar system that highly organized organic life exists. There is a great deal of evidence that even now our earth is being driven outside of that zone in which the delicate heat balance necessary to life exists and our race "is probably destined to die of cold, while the greater part of the substance of the universe still remains too hot for life to obtain a footing." It is, therefore, natural to ask if all that life amounts to is "clinging on to a fragment of a grain of sand until we are frozen off, to strut our tiny hour on our tiny stage with the knowledge that our aspirations are all doomed to final frustration, and that our achievements must perish with our race, leaving the universe as though we had never been?" While astronomy may have suggested this question, to answer it, or even to see in which direction the answer lies, we must delve deep into the fundamental nature of things and this will carry us right into the middle of modern physics.

In the Nineteenth Century the aim of all natural science was to find a mechanical model which would represent the phenomena studied. Mechanics is only one of the many manifestations of nature, but it was not realized until the Twentieth Century that any attempt to represent the whole by arrangements of a few of its parts is almost certainly doomed to failure. If the universe cannot be treated as a huge machine, to what then does it correspond? Before answering this question Jeans discusses briefly but vividly the more important theories, or rather principles upon which modern physics depends. Upon analysing them it is found that they reduce to a group of mathematical formulations for which in most cases there is no adequate mechanical model.

Even in such cases as that of wave-mechanics, where we seem to have a more or less definite physical picture of affairs, we find that either the system of Heisenberg or that of Dirac, which offers no such physical picture, leads us to much the same conclusions. In any event we find "that *all* the pictures which science now draws of nature, and which alone seem capable of according with observational fact, are *mathematical* pictures." The materials used are not the ordinary mathematical ideas which experience with the external world forces upon us but consist of some of the most abstract creations of pure thought. In fact "the universe begins to look more like a great thought than like a great machine." Jeans furthermore states that "a scientific study of the action of the universe has suggested a conclusion which may be summed up, though very crudely and quite inadequately, because we have no language at our command except that derived from our terrestrial concepts and experiences, in the statement that the universe (*Concluded on page 214*)

THE INSTITUTE GAZETTE

Advance on Annual Dinner

FROM President Thomas C. Desmond, '09, and the Committee on Assemblies comes information about the plans for the Dinner of the Alumni Association annually held in Boston. This year, the date for the occasion has been set as the last day in February and the place, the Hotel Statler, as it was two years ago. An innovation instituted this year by President Desmond is the invitation that will be extended to the wives and women friends of all Alumni. Alumnae, of course, have always been welcome at these dinners, and now for the first time attending Alumni are permitted, in fact requested, to bring friends with them.

Other departures from previous procedure are promised by President Desmond and the Committee. For those who wish, facilities for dancing will be provided after the dinner, and a reception will take place before the dinner, enabling the guests to meet Dr. and Mrs. Compton, Dr. Stratton, and the heads of the various departments. There will also be an Institute exhibit presented under the care of Bursar Ford. There will be a minimum amount of speaking, and the annual report on the state of the Institute will be presented at this dinner in written form, a pamphlet including it being placed at the plate of each guest.

New York Dinner

THE REVIEW hastens to commend the Technology Club of New York for its delightful dinner to President Compton on December 8. It was an event well planned and managed, one that captured that evanescent quality that raises an over-worked routine to an occasion of spontaneous enjoyment. The Technology Club of New York may well be proud of the enthusiastic welcome accorded Dr. Stratton and Dr. Compton, Technology's administrative leaders. Preceding the dinner, a reception afforded all an opportunity to meet Dr. and Mrs. Compton, Dr. Stratton, and other representatives of the Institute and its Alumni body.

Gerard Swope, '95, introduced the guest of honor, Dr. Compton, who was the principal speaker of the evening. Dr. Compton delighted all with his recitation of plans for future developments of Technology. High lights of his remarks were: the announcement of the construction of a new physics and chemistry building which will close the court facing Walker Memorial (see below), between buildings two and eight; a spectroscopic and cryogenic laboratory to be constructed soon; laudation of the existing coöperative spirit on the part of the entire Instructing Staff and Alumni to make Technology a greater center for scientific research and learning. Dr. Compton spoke highly of the joint Student-Faculty Committee formed to study necessary curriculum changes and ways and means to increase the effectiveness of instruction.

Dr. Samuel W. Stratton, Chairman of the Board, preceded Dr. Compton, and expressed to the assembled group the best wishes of the Corporation. He remarked about the unfortunate death of three life-long friends of Technology: Frederick P. Fish, George Wigglesworth, and T. Coleman duPont, '84. Dr. Stratton also told of the recent unveiling of a tablet at the University of Virginia in honor of William Barton Rogers, Technology's founder and first President.

From a rendering by C. J. Chamales, '31

THE NEW PHYSICS AND CHEMISTRY BUILDING FOR WHICH CONTRACTS HAVE RECENTLY BEEN LET. HARRY J. CARLSON, '92, IS THE ARCHITECT AND THE SPECTROSCOPIC LABORATORY, WHICH IS TO BE AT THE REAR OF THE BUILDING SHOWN ABOVE, WAS DESIGNED BY CHARLES T. MAIN (CHARLES T. MAIN, '76, CHARLES R. MAIN, '09), INC.

As toastmaster of the evening, Richard H. Ranger, '11, President of the Technology Club of New York, set a high standard. His introductions were short, terse, and yet interwoven with effective wit and accompanied by a contagious smile. In speaking of future plans for the club, Mr. Ranger remarked that a benefit performance would be held at some New York theatre during the present winter, the proceeds from which would be used to assist in defraying the expenses of entering the Technology Crew in the Poughkeepsie regatta for 1931.

"Beginning in January," he stated, "monthly seminars will be held at the club which will afford all Alumni the opportunity of keeping in closer touch with the latest developments at the Institute and their respective fields."

One of the outstanding features of this dinner was an exhibit of motion pictures showing Dr. Compton's inaugural ceremony and the 1930 All-Technology Reunion held in June. Bursar Ford and Professor R. H. Smith were responsible for an exhibition in picture form depicting student activities, and the various courses of instruction offered at the Institute. Last (and this is mentioned with appropriate blushing) was an exhibition of The Technology Review covers for the last four years.

To stimulate and to control vocal eruptions, there was present Orville B. Denison, '11, Technology's ubiquitous cheer leader. Harold Patrick rendered a vocal selection, and with Denny led the audience in singing "Take Me Back to Tech." To terminate the very excellent program, Stephen Townsend inspired and led the singing of the "Stein Song" in a manner which would have made the beer age envious.

Progress in Civil Engineering

JOHN SMEATON (1724–1792), author of "An Experimental Inquiry Concerning the Native Powers of Water and Wind to turn Mills and other Machines depending on a Circular Motion," is credited with coining the appellation "Civil Engineer." Until the Eighteenth Century most of the mechanical and constructional arts were the vocation of the military engineer, but during that hundred-year period the development of steam motive power brought many brilliant civilians such as Brindley, Watt, and Smeaton into the field, and the last named seeing the inappropriateness of assuming a title hitherto belonging to the military, adopted the title "Civil Engineer."

With this conception of the profession the Institution of Civil Engineers was founded in England and this body defined their profession as "the art of directing the great sources of power in Nature for the use and convenience of man."

That civil engineers still adhere to this broad definition is evinced by the new fields the Institute's Department of Civil and Sanitary Engineering has entered. Two new subjects, one in geodesy and seismology and the other in aerial transportation, have been added to its curriculum. That in geodesy and seismology is considered most important because it will provide for training in seismology based upon fundamental physics and engineering subjects. Since civil engineering is responsible for the design of such structures as dams, bridges, and the modern high buildings, it is fitting that the forces applied to structures by earthquakes should be studied and taken into account in the design of these structures. Research and advanced instruction in soil mechanics and foundation engineering have been in progress for some years and among the present projects is one in which the United States Bureau of Public Roads is coöperating with the Institute.

The course in geodesy provides for further extension of the work already undertaken, and a seismograph of advanced design is under construction for installation at the summer civil engineering camp of the Department at East Machias, Maine, where the seismological observatory has already been built and is ready for the instruments. In this work the Institute will coöperate with the United States Coast and Geodetic Survey. The program of geodetic work already includes precise studies in the subject of land movements and changes in elevation, and important surveys in this connection have been made at the camp.

A new group of studies dealing with air transportation has been added to the elective work offered in the fourth year to students taking the transportation option. Students electing this option will be required to take certain subjects offered by the Department of Aeronautical Engineering in order to give them the necessary aeronautical background, and the regular course in structural design offered to all civil engineering students will be modified to include problems in the analysis of airplane stresses.

Other subjects required of all students in the transportation option deal with the fundamental problems occurring in the design and construction of airports, hangars, mooring masts, and the like. In the last ten years a number of graduates of the Course in Civil Engineering have been engaged in aeronautical engineering, particularly in the structural design of airplanes, for which their training in the theory of structures has well fitted them. Several of these graduates are now among the leaders in this special branch of the aeronautical field.

Ciencia y Conciencia

FEW subjects exert a greater appeal to the public than science. Few subjects are so misunderstood. It is with good reason, therefore, that the Institute seeks by lecture and experiment to disseminate accurate information about "the greatest edifice built by modern thought." Each year it offers to the youth and public of Boston a series of lectures with experiments known as the Popular Science Lectures of the Society of Arts. Each year the combined audiences of the series (each lecture is given thrice) exceed 6,000. The lectures are given in Room 10-250 of the main educational group.

The 1930–31 series opened on December 12 with "Grand Adventure with the Mining Engineer" given by Professor W. Spencer Hutchinson, '92. Three others yet remain. They are:

RECENT DEVELOPMENTS IN COMMUNICATION BY RADIO, by Professor Edward L. Bowles, '22. January 16, 17, 18.

SOME CONTRIBUTIONS OF ORGANIC CHEMISTRY TO DAILY LIFE, by Professor Ernest H. Huntress, '20. February 13, 14, 15.

X-RAYS AND THE STRUCTURE OF CYRSTALS, by Professor Bertram E. Warren, '24. March 13, 14, 15.

The 148th Alumni Council Meeting

THE 77 who were present at the meeting of the Alumni Council on November 24 and heard Frederick A. Hannah, '95, give his revelatory description of conditions in Russia will be shocked to learn that he died suddenly on December 6. After Mr. Hannah's trip to Boston to speak to the Council, it transpired that he was not in the best of health, although there was no indication that his trouble was serious. In behalf of the Council and Institute Alumni, this opportunity is taken to express the sorrow of all in Mr. Hannah's sudden demise.

During the past year, the Council has lost many members by death, and at its last meeting it was its duty to memorialize one of its former Presidents, T. Coleman duPont, '84. A committee consisting of Walter Humphreys, '97, Franklin B. Richards, '84, and Augustus H. Gill, '84, Chairman, prepared the following resolutions which were presented by Professor Gill:

"Whereas our former distinguished president, General T. Coleman duPont, has recently passed into spirit life:

"Resolved that the Alumni Council of the Massachusetts Institute of Technology recalls with much gratitude his keen interest in the Institute, particularly in the Mining and Chemical Departments.

"It remembers with especial satisfaction his outstanding success in raising, in the Alumni Endowment Fund drive, the sum necessary to supplement Mr. Eastman's generous offer. It wishes further to express its grateful appreciation of his own munificent and frequent gifts to the Institute, for its size, its buildings, and its funds: no worthy call, whether of Corporation or student, was unanswered.

"It desires to place on record its high esteem of the kindly, companionable, and public-spirited man, and its admiration for the patience, cheerfulness, and fortitude displayed in combating a fatal malady.

"We extend our heartfelt sympathy to his wife and family, and are grateful that we have been permitted to share with them in a life so magnanimous and full of achievement.

"Resolved that a copy of these resolutions be sent to his family and spread upon our records."

President Desmond presided over the Council meeting for the first time since his election to office last spring. He was given a rousing cheer in honor of his election as Senator of the State of New York on the Republican ticket. In acknowledgment, Mr. Desmond expressed his regret that his political activities prevented his attending the October meeting of the Council.

He presented several suggestions for the Annual Dinner of the Association, stating that the date had been set by the Executive Committee as February 28. He asked for discussion on the advisability of having women at this dinner and of having a dance to follow it. The Council seemed apathetic and no discussion ensued on either point, although there were a few desultory remarks on the choice of the hotel — a selection left to the Committee on Assemblies.

President Compton was present and spoke briefly following Mr. Hannah's address, recalling the experiences of some of his friends in the field of physics who are Russians. He likewise expressed his felicitations to Mr. Desmond upon his election to the New York State Senate.

The remainder of the meeting was taken up by routine reports, by the announcement and introduction (if present) of the following new members of the Council: Arthur L. Townsend, '13, representing Washington; Karl L. Wildes, '22, representing Schenectady; William M. Bassett, '02, representing Worcester; and Samuel P. Mulliken, '87, representing his Class.

It was also announced that William P. Ryan, '18, had been transferred from the Springfield Club to the Buffalo Club, and Ernest C. Crocker, '14, from the Buffalo Club to the Springfield Club, this change being made because Professor Ryan makes frequent trips to Buffalo.

Engineers in Who's Who

DONALD PRENTICE and B. W. Kunkel of Lafayette College have presented in *School and Society* a list of who's who among the colleges. This was the result of a study made of the 1928–29 edition of "Who's Who" which records some 28,805 biographies, of which 16,433 received their bachelor degrees from American institutions. In spite of the fact that institutions training engineers have a lower index than those training ministers and professors, Technology ranks 11, with 240 graduates represented, out of the 506 different colleges and universities therein mentioned. Harvard takes first place with 1,374 graduates, then Yale and Princeton with 937 and 480 graduates respectively, while the University of Pennsylvania immediately precedes the Institute with 261 graduates.

Aside from this classification by the total number of graduates, a comparison was made with the total number of living graduates of the respective institutions. The comparison is noteworthy although weakened by the fact that only 70 institutions replied to the request for information. This new ranking presents interesting variations: Technology's per cent of 2.02 puts it at number 31, Harvard drops to third place and Yale to sixth. Hampden-Sydney rises from 81 to first place and the College of Wooster, from which the President of Technology was graduated, rises from 52 to 27 in rank.

George Wigglesworth (1853–1930)

DEATH this year has brought irreparable losses to the Institute, particularly among the group of pioneers who have had so much to do with its founding and upbuilding. The latest is that of George Wigglesworth, Life Member of the Corporation since 1891, Treasurer of the Institute for 1891 to 1907, and ex-officio member of the Executive Committee during that period.

Mr. Wigglesworth died suddenly in Bermuda on November 26, 1930. One of Boston's most honored citizens, a member of one of Massachusetts' most prominent families, he gave himself without stint to many great educational and charitable enterprises. He was President of the Harvard Board of Overseers, the Harvard Alumni Association, the Massachusetts General Hospital, and one of the trustees of Wentworth Institute. His interest in Technology was unflagging, and he was a familiar figure to all Technology men by virtue of his regular attendance at all Institute functions.

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MACHINE AGE POLITICS

(*Continued from page 182*)

In 1876 some 85% of the qualified voters cast their ballots. The figure dropped to 75% in 1904, 60% in 1912, and 50% in 1924. Despite vigorous endeavors to get all enfranchised citizens to the polls, millions refused to stir.

Then suddenly the practices and calculations of early days were brushed aside by a modern Stentor, a Stentor of metal and glass, a Stentor with electric nerves, the radio! During the presidential campaign of 1928, the first in which it was brought into general play, some two million dollars were spent by the two leading parties on broadcasting arguments and programs. At last it was possible for a prospective chief executive to reach an estimated audience of between 30 and 40 million persons in a night or two. What would the Greeks have thought of such a herald? As one newspaper said, "radio deserves credit for stirring up an interest in politics never before so strongly manifested in the history of this country. It has revealed the characteristics of personality of the outstanding candidates intimately to the calm and calculating judgment of the millions of their constiuents from coast to coast." What the printing press and the mass meeting failed to do the radio bids fair to achieve. It brings governor and governed together for personal chats in the home. The efficient State of the Greeks spreads from thousands to millions. And the percent of the eligible voters casting ballots rose from 50 in 1924 to over 60 in 1928, the first positive upward trend in half a century.

Not only did certain of the Greeks deplore the unwieldiness of giant nations, but they denounced the demagogue. Now the electrical Stentor, who has eliminated most of the political objections to large populations, has performed the added feat of casting out the devils of the soap-box orator. In the first place, radio broadcasts reach the home directly. Individual listeners, at ease in their own quarters, hear the facts presented by the distant speaker. There can be no mob psychology under these conditions. Reasoned arguments must win the voter or he will drown his disgust by turning a knob to jazz. Secondly, the radio audience is immense, and the cost of broadcasting is enormous. One cannot hire a hall housing half a continent for nothing. Consequently nationally known figures, who would not bother to stump the country and appear before many small gatherings, feel honored by the privilege of facing the microphone and take leadership in forming public opinion. Conversely, the "tin pot" politician, given to the big noise, sinks into the background, for campaign managers cannot afford to turn him loose at great expense on the radio audience. So Billy Sunday tactics, torch-light parades, monster demonstrations, and hectic tom-tom beating seemed doomed to a steady decline. The radio alone has changed the very face of democratic government.

THE technological drive in government has also broken down historical relations between political units, just as it has changed the linkage between governors and governed. To be sure, the custom of parceling off the world and each country into little areas under separate rule continues unabated. In the United States this habit is responsible for the (*Continued on page 206*)

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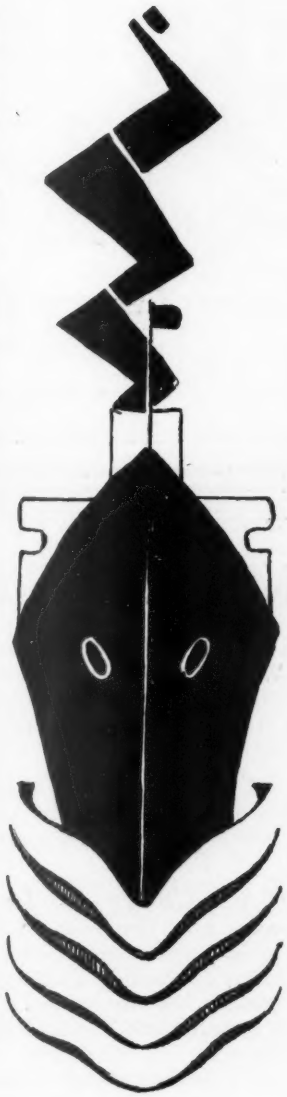

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MACHINE AGE POLITICS

(Continued from page 204)

fierce battle always raging over states' rights. In general it is responsible for the spirit of nationalism which so often sets the world aflame. But the cable, the railway, the radio, air mail, and their companions of iron and steel are steadily raising new questions respecting political boundaries.

How far is ancient sectionalism compatible with the operating requirements of modern technology? Here is a big issue for the future to face. With reference to our internal political divisions, light can be thrown upon it by an interesting judicial opinion recently rendered. In Whitehurst *v.* Grimes [21 F. (2d) 787] it was held that "radio communications are *all* interstate. This is so, though they may be *intended* only for intrastate transmission. . . . Such communications admit of and require a uniform system of regulation and control throughout the United States, and Congress has covered the field by appropriate legislation." This sweeping statement, although a shock to old-line publicists, is the only one possible in the circumstances. If a person "intends" to send a message by radio between two towns a few miles apart, in Ohio let us say, his transmission can be picked up on receivers located between those points, which may at the same time be capable of catching messages from other states. Such devices amplify all signals, regardless of their geographical origin. If the operators of these intermediate receivers hear the supposedly "intrastate" message at the same time that they are picking up Indiana stations, and interference results, the owners can bring the sender of the "local" signals before a federal court as a disturber of interstate commerce in the form of reception. And where, pray tell, can one find an inhabited part of the country in which "interstate" receivers are not in operation today or, at least, likely to be installed at any moment? Technology, supported by the law, has utterly annihilated the boundaries between the states in one branch of communication.

Nor do international boundaries fare any better. During the early part of 1930 a 100-kilowatt broadcasting plant in Moscow delivered Communist orations in the German, French, English, Swedish, Polish, and Rumanian languages. Germany protested against the programs sent out in her own tongue but was informed that they were solely for the benefit of German settlers in the Volga basin of Russia — local messages "unfortunately" heard abroad! What was to be done about this new medium, the radio, which could not be halted at the borders between nations, which could not be captured and punished? Rumania chose a drastic course. Through her Bucharest broadcast station she systematically sent out interference signals which are said to have completely blanketed the Moscow programs in Rumanian the moment they began. *(Continued on page 208)*

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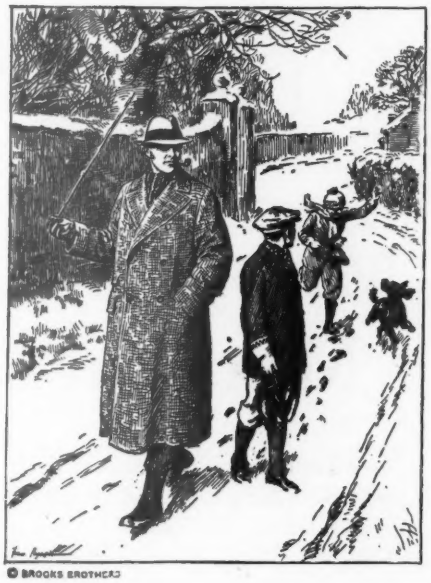

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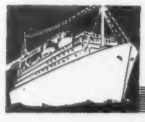

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MACHINE AGE POLITICS

(Continued from page 206)

A cheerful thought, perhaps, but what if everyone chose to do the same thing? Little would then be heard except interference signals on the broadcast band and the radio as a medium of entertainment and education would fold up its wings and succumb to an early death. This fact Germany realized. If she sent out interference signals to garble the Moscow programs in German, she would also prevent the reading of local ship signals and tie up harbor traffic. On the other hand if she tried to retaliate by sending abroad anti-Communist speeches in Russian, Moscow might easily blot them out by interference. This little game of mutual distrust, then, would benefit nobody if carried very far. Evidently, wireless can and will ignore human frontiers and only international government, such as that represented in the periodic international radiotelegraphic conventions, can cope with the world-wide problems it has raised. Nor will the growth of traffic by airplane serve to make borders any more distinct.

We have seen how the technological drive in politics has left its mark on the internal structure and functions of the State, and on the relations of governments to their citizens as well as to one another. Evidently government is in process of change. In the upheaval which we are experiencing, our inherited ideas are doomed to be thrown in the melting pot, emerging in new molds. Fortunately, in the turmoil, the ingenuity and machinery which have carried us into the modern maze have brought with them a method helpful in finding a way out — the scientific method. This process is rarely exact, even in the industrial arts, as engineers know full well, but it is the most effective intellectual instrument which we have for ascertaining truth about difficult situations and cutting our way out of them.

AND this is not merely a dim hope. Already the scientific method is recasting the study of political institutions in our colleges and universities — slowly, very slowly, but inevitably — and it is being made manifest concretely in the phenomenal growth and activities of governmental research agencies in all parts of the country. These groups, of which the National Institute of Public Administration in New York City is typical, go out into the field, observe government at work, and gather the facts in the case — very much in the spirit of the biological expert dealing with *(Concluded on page 210)*

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MACHINE AGE POLITICS

(*Concluded from page 208*)

a phase of nature. They then review their findings, develop and apply scientific criteria with reference to desirable ends, and suggest changes, which they proceed to put into effect wherever feasible. Learning from these experiments, they build up a body of precise knowledge which aids them in avoiding pitfalls in the future. Under their guidance or inspiration, whole states have been reorganized, while the entire Federal Government has been closely analyzed, though not yet overhauled in a comprehensive manner. Russia's titanic efforts in the direction of a planned national economy, taking in every strata of society and every type of work, draws the attention of the world. With all her faults and mistakes, repugnant as many of her pronouncements seem to us, she is attempting the rationalization of government and economy along technological lines.

Can the mind of little man succeed in integrating and rationalizing the Great Society of our day — a Society in which the steamship, the airplane, the radio, the mine, the factory, the press, the farm, and the home each plays a rôle in a huge drama? Certainly not without the exercise of the highest intelligence that can be commanded and the best use of the scientific method. Those cynics who declare that there is no room for intelligence in the machine age simply ignore the facts. Already America's effort to eliminate the calamity of industrial depression, stabilize agriculture, and assure peace to world intercourse requires all the mental powers we possess. And the end of eternity is still a long way off.

AN AMERICAN FARADAY

(*Continued from page 186*)

an account of a new method of grinding and polishing glass mirrors such as are used in telescopes. At the present time he has entrusted to his inventive skill the problem of constructing the largest telescope mirror ever undertaken, the proposed 200-inch reflector for the great new astronomical observatory to be associated with the California Institute of Technology and the Mt. Wilson Observatory, near Pasadena. This telescope mirror will have four times the area of the largest mirror hitherto constructed, and in order to give it adequate strength and freedom from distortion under the influence of the heating by the sun's rays, it is planned to construct it of fused quartz. This is an optical engineering feat of such magnitude as to challenge the best scientific knowledge and inventive skill in the world, for it is a project of a different order of magnitude from any hitherto undertaken in this field.

As a background for this important undertaking, Professor Thomson has for many years been perfecting a method of manufacturing fused quartz which has proved remarkably successful in permitting the construction of quartz apparatus by machinery, in size and quality hitherto unapproached. The quartz is melted in a specially designed electric furnace, is forced under pressure into forms or moulds and, solidifying under pressure, the small air bubbles always present (*Continued on page 212*)

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AN AMERICAN FARADAY

(Continued from page 210)

in earlier quartz ware are compressed to such small dimensions as to be entirely invisible, thus a tremendous advance over the old-fashioned method of building up quartz apparatus by the individual work of a glass blower building on dab after dab of quartz under a blow pipe flame. This new type of quartz ware, besides making possible the great mirror, is also coming to be extensively used as a transmission glass for ultra-violet light in hospitals and in special lamps. It has also furnished the material making possible windows in deep sea diving bells where its ability to withstand the enormous pressures has made possible deep sea investigations of much greater depth than before.

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In order to give some idea of the scientific and philosophical scope of Professor Thomson's various discoveries, it would not be amiss to present here the titles of various publications in fields which are quite outside any of those already mentioned: *Change of Color Produced in Certain Chemical Compounds by Heat; Inhalation of Nitrous Oxide, Nitrogen, Hydrogen, and Other Gases and Gaseous Mixtures; On Recalescence in Steel and its Relation to Expansion, Magnetization and Hardening; Physiological Effects of Alternating Currents of High Frequency; Thoughts on Cosmical Electricity; Speculation Regarding Cause of Röntgen Rays; The Nature of the Lightning Discharge; The Nature and Origin of Volcanic Heat; The Nature of Comets and their Probable Relation to the Sun; The Light of the Firefly; A Hunt for a Great Meteor and its Lessons; Inferences Concerning Auroras; Notes on the Moon; The Heaviside Theory Valid?; Comments on the Coal Situation; The Solar Eclipse of January 24, 1925; Helium in Deep Diving; A Suggestion or Hypothesis Concerning Zodiacal Light.*

More than any man now living, or in fact, more than any man in history, Professor Thomson has combined in a most remarkable way the constructive powers of the inventor, the thoroughness and soundness of the man of science, and the kindly balance of the ideal philosopher, teacher, and friend. Because of these qualities he is held in equally high esteem by practical engineers and in the most highbrow academic circles. He has always shunned publicity and because of this his *(Concluded on page 214)*

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AN AMERICAN FARADAY

(*Concluded from page 212*)

achievements have not been highly advertised or made common objects of front page newspaper publicity, but I think all will agree from this summary of his work that a fair appraisal of its importance to the industrial and intellectual interest of the entire world, demonstrates that this man deserves in every way the tribute which was paid him by my predecessor and his friend, Dr. Richard C. Maclaurin, President of Technology from 1909–1920, who said: "In his laboratory, built right into his house and an integral part of it, he is a man from whose mind probably thoughts on scientific problems are never wholly absent, an unselfish genius, well-trained, well-rounded, well-balanced man of science," or in the words of the *Electrical World* on the occasion of the awarding to Professor Thomson of the Faraday medal of Great Britain in 1927: "And how proud the electrical industry is of her Swampscott inventor, philosopher and friend. Of all men living none except Edison has brought her so much honor and renown."

BOOKS

(*Concluded from page 199*)

appears to have been designed by a pure mathematician."

To the professional philosopher Jeans' conclusions will probably seem a confused mixture of realism and idealism, but his account of modern scientific theories, upon which these conclusions are based, is a model of clear, brilliant, and captivating exposition. No one who has any knowledge of the almost mystical mathematical operations used in modern physics will look upon Jeans' conclusion as mere sublimated anthropomorphism. Rather will he suspect with Jeans "that the universe shows evidence of a designing or controlling power that has something in common with our own individual minds — not, so far as we have discovered, emotion, morality, or æsthetic appreciation, but the tendency to think in a way which, for want of a better word, we describe as mathematical."

In any event, because of its clarity of thought and beauty of exposition, "The Mysterious Universe" will appeal equally to the layman, physicist, mathematician, and philosopher.

THOMAS J. KILLIAN

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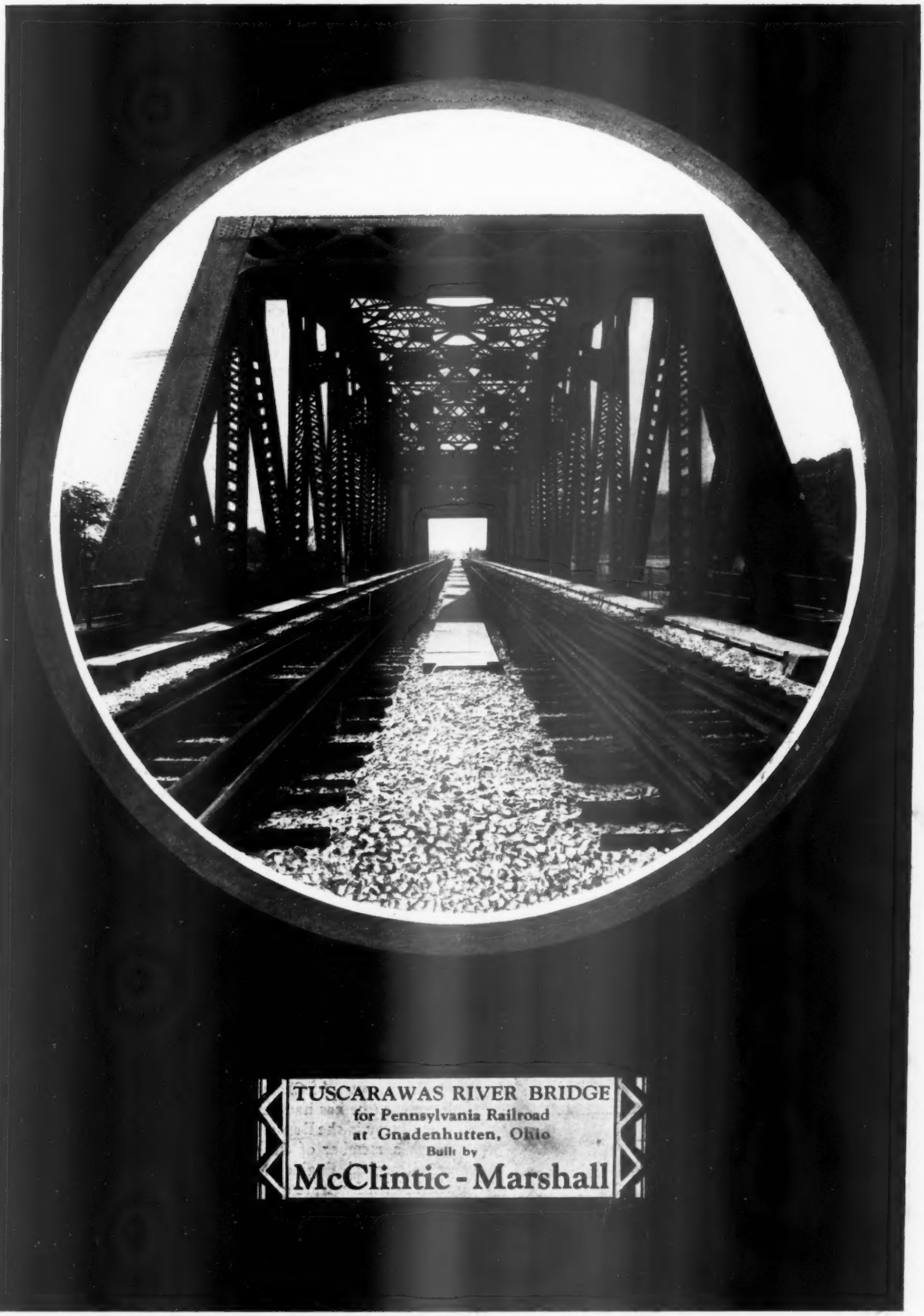

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THE TABULAR VIEW

NICHOLAS MURRAY BUTLER scarcely needs an introduction to the world for he is known both here and in Europe as a prominent educator. His varied activities make an imposing list — too numerous to include in this column. Since 1902 Mr. Butler has been President of Columbia University, from which college he received his bachelor's, master's, and doctor's degrees. His dominant interest is in the field of education, where he is constantly facing the problem of indifference to higher education and prejudice as to its real significance. To quote from his annual report in 1925: "If Abelard came back, he would be confronted with the spectacle of countless numbers of men and women, all hugely pleased with the brightness of their own intellectual illumination, whose minds are blocked to the progress of reason by the barriers of prejudice and fanatical prepossession." ¶ Mr. Butler is aptly called a modern Abelard, confronted as he is with the well-meaning ignorance of an uncomprehending world, and he is ever trying to raise the standards of a people complacently accepting mediocrity for excellence. President Butler's reports are far from a perfunctory annual duty; they represent a valuable, up-to-date survey of conditions in education as they exist today. Although he has written many books, essays, and addresses which are comprehensive in scope, he comes back again and again to certain favorite subjects: democracy and government, philosophy and education, and international peace. His article entitled "Science Endangered" is an excerpt from his report for 1930 as President of Columbia University.

IN THESE days when it is fashionable to abominate royalty, more consideration might well be given to royalty's by-products. The power of royal prestige has been and may be a deciding factor in the introduction of everyday utilities. Let us consider two contributions of royalty to science. The instance described by Professor Williams in his article on page 229 is an example, for aluminum undoubtedly received an impetus toward a greater use by virtue of the glee of the Prince Imperial over a rattle made of it. Another example of royalty's aid to science was recorded in the December Review and sharpens the point — the popularization of chloroform by Queen Victoria's use of it at the birth of Prince Leopold. Royal patronage, we conclude, is a most effective means of advertising. ¶ Dr. ROBERT S. WILLIAMS, the author of "The Evolution of A Baby Rattle," was graduated from Technology in 1902. He received his Ph.D. from Göttingen in 1907 and was connected with the Department of Chemistry from that time until 1927. Since then he has had charge of the Division of Physical Metallurgy in the Department of Mining and Metallurgy. He is a member of the Chemical Society, Mining and Metallurgical Engineers, the American Academy, and the British Institute of Metals.

"INVENTION AND ECONOMICS" by B. ALDEN THRESHER deals with the problem of innovation in its effect upon society, a subject that the current business

(*Continued on page 220*)

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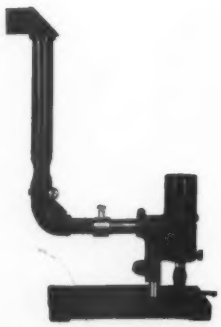

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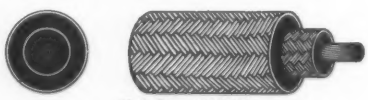

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THE TABULAR VIEW

(Continued from page 218)

depression has given real immediacy. Elmer Davis in a recent letter to the Editor of the New York *Times* remarked: "Classical economics, again, tells us that if men are laid off because of an improved process, the saving will lead indirectly to the creation of new jobs somewhere else to take care of them. But every corner has its apple seller already. Till applied social science catches up with applied physical science, every improvement in the mechanics of living is a disaster for somebody and somebody's wife and children." ¶ Economists have been too arbitrary in assuming that invention is always helpful, for the subject has not been studied sufficiently. Mr. Thresher points out that there is a specific demand for systematic analysis of the economic effects of this principle of innovation in relation to modern life. The world looks to research on a scientific basis to predict the trend of results and to help solve this serious problem. This means that the economist must acquire the engineering as well as the financial attitude. ¶ Mr. Thresher was graduated from the Institute in 1920. For seven years he was engaged in engineering, executive and research work in textile, paper products and food products industries. In this connection he has contributed various technical articles from time to time to the *Textile World*. An active interest in economics led him to study further in this field beginning in 1927, and he received his master's degree from Harvard University the following year. Before becoming an instructor in the Department of Economics at the Institute in 1929, he held the Henry Lee Memorial Fellowship in Economics at Harvard University.

HAROLD E. LOBDELL, '17, is publisher of The Review and Dean of Undergraduates at M. I. T. His extensive study of railroad speeds answers questions one so often hears posed: what are the fastest trains, and are American trains as fast as those in Europe? Dean Lobdell is rapidly becoming an expert railroad statistician, an accomplishment to which few of us can aspire, but which all of us severally admire.

THE book reviewer for this issue is Dr. James A. Tobey, who has been a frequent contributor to The Review. In November, 1929, he wrote the article about human longevity, "Forestalling Death," and in March, 1930, he contributed the article entitled "Business Discovers Health," showing how commerce employs science to aid public well-being. Dr. Tobey, who was graduated from Technology in 1915, has been very active in the service of the National Health Council. He has also served as health officer of Summit and West Orange, N. J., as representative of the State Department of Health, scientific assistant with the United States Public Health Service, and has been connected with the Sanitary Service of the Red Cross. During the war he was first lieutenant in the United States Army Sanitary Corps. In 1922 he was admitted to the Bar of Washington, D. C. As a result of his studies he has written many articles and books, be-

(Concluded on page 222)

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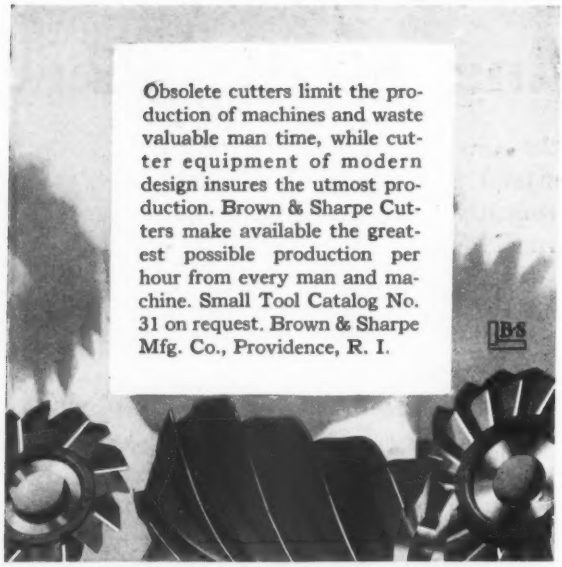
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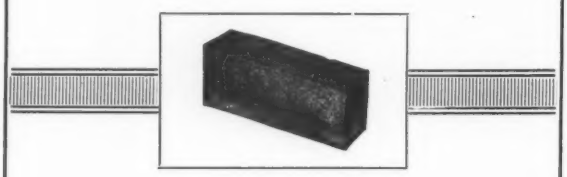

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THE TABULAR VIEW

(Concluded from page 220)

sides being Associate Editor of the American Journal of Public Health. In 1930 he became Director of Health Service of The Borden Company in New York.

TO HUXLEY has been attributed the remark that six monkeys set to pound unintelligently for millions of millions of years on typewriters would be bound in time to write all the books in the British Museum. The reverse operation of this law of probability unfortunately applies to the appearance of errors in magazines and books. To its unescapable operation (we would, of course, admit no other reason) may be attributed those errors which appear in The Review. As an example we point to the biographical note on Mr. Harold B. Warren in this column last December. Mr. Warren was never a Professor of Landscape Architecture at either the Institute or Harvard University, but instead he was for a good many years instructor in Drawing and Water Color in the Schools of Architecture and Landscape Architecture at Harvard University, from both of which positions he has just retired.

ON THE 126th birthday of William Barton Rogers, the founder of Technology, a tablet was dedicated to his memory. LAUREN B. HITCHCOCK describes these impressive exercises in this issue of The Review, giving an idea of Dr. Rogers' activities at the University of Virginia. Professor Hitchcock took the course in Chemical Engineering at the Institute, graduating in the Class of 1920, and in 1927 he obtained his master's degree. At the present time he is an Associate Professor in the school of Chemical Engineering at the University of Virginia.

THE water color reproduced on the cover of this issue was executed by CASS GILBERT, '80, in 1924. It pictures Marldon Church in England, the church of his ancestors. Mr. Gilbert has achieved world-wide distinction as an architect, being particularly well known as the designer of the Woolworth Building and as the architectural advisor on the new Hudson River Bridge and the Kill van Kull Bridge. He is a member and a director of the American Academy of Arts and Letters. In 1928 he was reëlected President of the National Academy of Design.

REQUESTS come to us at intervals for editorial treatment of subjects dear to the hearts of Review readers. One reader, for example, requested a study of the wood pulp situation, a request to which we promptly conceded as indicated by the article on that subject in the December number. At the suggestion of another reader we looked into glass technology in America and "A Sermon on Glass" was the result. With editorial abandon we herewith publicly announce we shall be receptive to all suggestions sent us, providing they fall within the scope of The REVIEW. We are also happy to receive any questions on science and engineering which derive from the reading of the magazine.

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